

National Aeronautics and
Space Administration

Headquarters

Washington, DC 20546-0001



OCT 5 1994

Reply to Attn of:

SS

TO: A/Administrator

FROM: S/Associate Administrator for Space Science

SUBJECT: Wind Prelaunch Mission Operations Report (MOR)

I am pleased to forward with this memorandum, the Prelaunch Mission Operations Report for Wind, the first of NASA's two missions of the Global Geospace Science (GGS) Initiative. The Wind laboratory will contribute to the understanding of the flow and coupling of mass, momentum, and energy from the Sun through the Earth's environment, known as geospace. Data acquired will be analyzed to formulate an understanding of the complex Sun-Earth interaction and their effects on space exploration, communication, and ground-based technology.

The spacecraft development was managed by NASA's Goddard Space Flight Center with the Martin Marietta Corporation, Astro-Space Division serving as the prime contractor. Overall programmatic direction was provided by NASA Headquarters, Office of Space Science. The spacecraft will be launched on a Delta II Expendable Launch Vehicle within a November 1-14, 1994, launch window. The Wind spacecraft carries six U.S. instruments, one French instrument, and the first Russian instrument ever to fly on an American satellite.

Wind is the second mission of the International Solar Terrestrial Physics (ISTP) Program. The first ISTP mission, Geotail, is a joint project of the Institute of Space and Astronautical Science of Japan and NASA which launched in 1992. Polar is scheduled for a November 1995 launch and will follow Wind as the second half of the GGS initiative.

A handwritten signature in dark ink, appearing to read "Wesley T. Huntress, Jr.", with a stylized, cursive-like script.

Wesley T. Huntress, Jr.

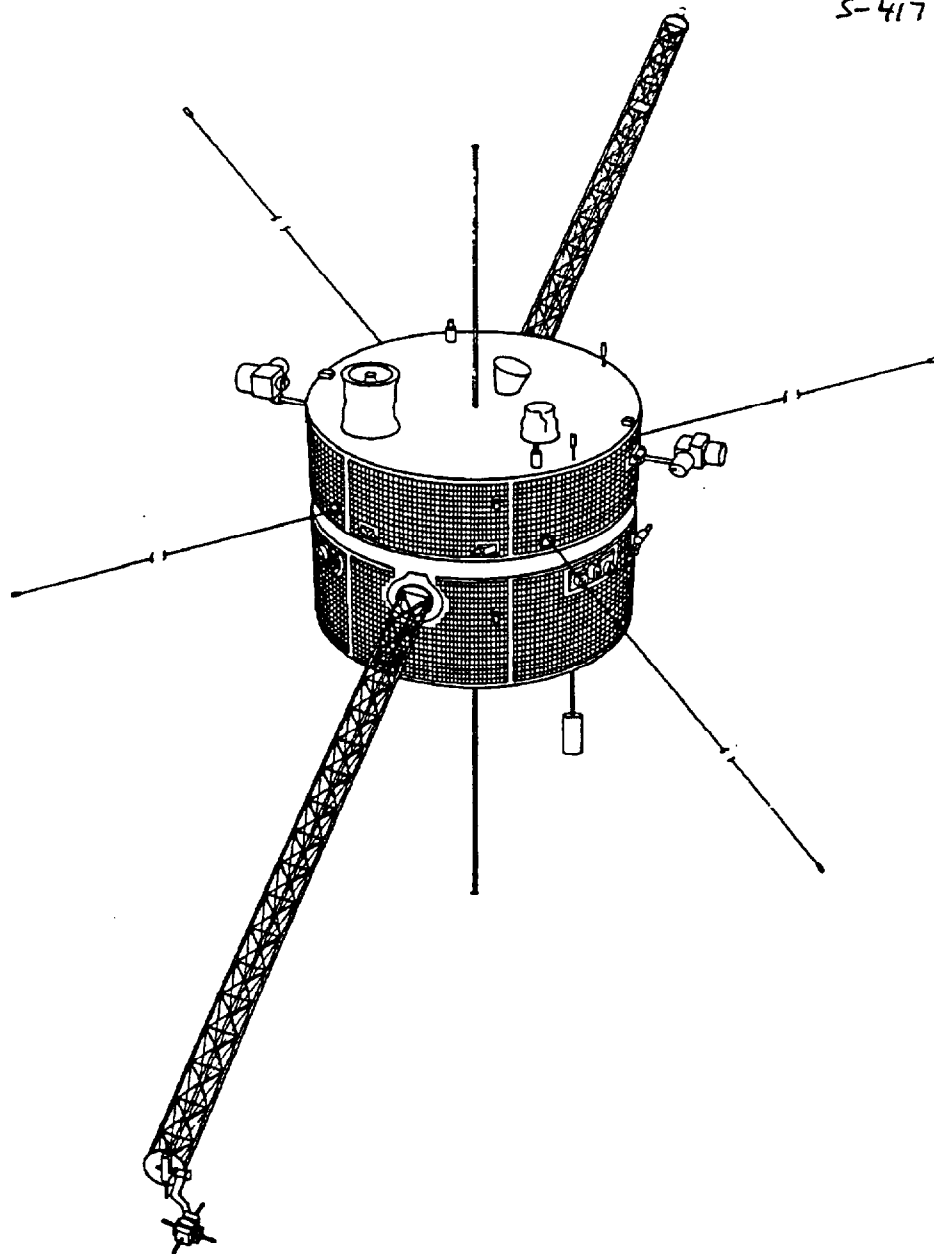
Enclosure



Mission Operations Report

OFFICE OF SPACE SCIENCE

Report No.
S-417-94-01



International Solar-Terrestrial Physics (ISTP) Program

Wind

Foreword

MISSION OPERATION REPORTS are published for the use of NASA Senior Management, as required by NASA Headquarters Management Instruction HQMI 8610.1C, effective November 26, 1991. The purpose of these reports is to document in advance critical discriminators selected to enable assessment of mission accomplishment.

Pre-Launch reports are prepared and issued for each flight project just prior to launch. Following Launch, updated (Post-Launch) reports are issued to provide mission status and progress in meeting mission objectives.

This report is technical in nature and is prepared for personnel having program/project management responsibilities. The Public Affairs Division publishes a comprehensive series of reports on NASA flight missions. These reports are available for dissemination to the news media.

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EXECUTIVE SUMMARY

The National Aeronautics and Space Administration (NASA) Wind mission is the first mission of the Global Geospace Science (GGS) initiative. The Wind laboratory will study the properties of particles and waves in the region between the Earth and the Sun. Using the Moon's gravity to save fuel, dual lunar swing-by orbits enable the spacecraft to sample regions close to and far from the Earth. During the three year mission, Wind will pass through the bow shock of Earth's magnetosphere to begin a thorough investigation of the solar wind. Mission objectives require spacecraft measurements in two orbits: lunar swing-by ellipses out to distances of 250 Earth radii (R_E) and a small orbit around the Lagrangian point L-1 that remains between the Earth and the Sun. Wind will be placed into an initial orbit for approximately 2 years. It will then be maneuvered into a transition orbit and ultimately into a halo orbit at the Earth-Sun L-1 point where it will operate for the remainder of its lifetime. The Wind satellite development was managed by NASA's Goddard Space Flight Center with the Martin Marietta Corporation, Astro-Space Division serving as the prime contractor. Overall programmatic direction was provided by NASA Headquarters, Office of Space Science. The spacecraft will be launched under a launch service contract with the McDonnell Douglas Corporation on a Delta II Expendable Launch Vehicle (ELV) within a November 1-14, 1994 launch window. The Wind spacecraft carries six U.S. instruments, one French instrument, and the first Russian instrument ever to fly on an American satellite.

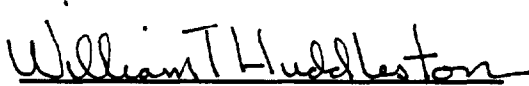
The Wind and Polar missions are the two components of the GGS Program. Wind is also the second mission of the International Solar Terrestrial Physics (ISTP) Program. The first ISTP mission, Geotail, is a joint project of the Institute of Space and Astronautical Science of Japan and NASA which launched in 1992. The Wind mission is planned to overlap Geotail by six months and Polar by one year. The Wind and Polar missions, together with the Geotail mission (launched on July 24, 1992) and supporting equatorial measurements, will provide simultaneous data to enable the study of solar wind input to the magnetosphere and key elements of the magnetospheric response: ring current energy storage, geomagnetic tail energy storage, and ionospheric energy input. Two European Space Agency/NASA cooperative missions, Solar and Heliospheric Observatory (SOHO) and Cluster, to be launched in 1995, will complement these measurements and improve our understanding of the physics of solar-terrestrial relations. The NASA contributions to Geotail, SOHO, and Cluster are referred to as the Collaborative Solar-Terrestrial Research (COSTR) Program. Together, NASA's GGS and COSTR Programs comprise the United States contribution to the International Solar-Terrestrial Physics (ISTP) science initiative.

SCIENCE OBJECTIVES

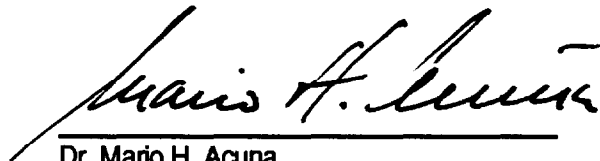
The science objectives of the Wind spacecraft contribute to the attainment of three fundamental science objectives of GGS. That is:

1. To measure the mass, momentum, and energy flows through geospace and understand their time variability;
2. To obtain detailed knowledge of plasma physical processes important in controlling the behavior of the major components of the geospace system; and
3. To determine the importance of changes in energy input to the Earth's atmosphere caused by geospace processes.

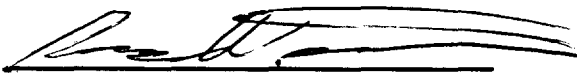
The minimum success criteria of the Wind mission is to provide characterization of the solar wind upstream from the magnetosphere with about one minute time resolution, with the goal of overlapping with the Geotail mission by six months and Polar by one year.



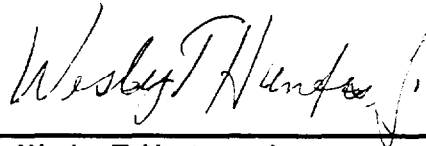
William T. Huddleston
Program Manager, Wind
Space Physics Division



Dr. Mario H. Acuna
Project Scientist, ISTP
Goddard Space Flight Center



Dr. George L. Withbroe
Director
Space Physics Division

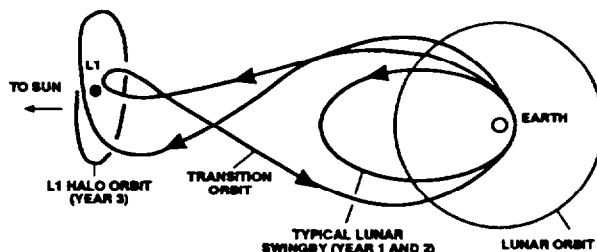


Dr. Wesley T. Huntress, Jr.
Associate Administrator
Office of Space Science

MISSION DESCRIPTION

OVERVIEW

The Wind spacecraft will carry six U.S. instruments, one French instrument, and the first Russian instrument to fly on an American satellite. Wind is scheduled to be launched on November 1, 1994 by a Delta II rocket from the Cape Canaveral Air Station (CCAS). The launch window extends fourteen days to November 14, 1994. An approximately fourteen day window exists each month if the November 1994 launch window is not met. The spacecraft will be launched into a figure-eight orbit around the Earth with its furthest point from the Earth's center (the apogee) as far as 250 Earth radii (1,600,000 km or 990,000 miles), and the closest point (the perigee) at least 4.5 Earth radii (29,000 km or 18,000 miles). Later in the mission, the Wind spacecraft will be inserted into a small circular orbit around the L-1 point (approximately 1,500,000 – 1,690,000 km or 930,000 – 1,050,000 miles Sunward of the Earth). See Figure 1.



WIND SPACECRAFT ORBITS

Figure 1.

Wind is the second in the series of solar terrestrial missions. The first, the Geotail satellite, is a joint mission of the Japanese Institute of Space and Astronautical Science (ISAS) and NASA which was launched in July of 1992 to study the behavior of plasma in the tail of Earth's magnetosphere. A third NASA satellite, Polar, will be launched in 1995 to measure the flow of plasma to and from the ionosphere. The Wind and Polar missions make up the Global Geospace Science Initiative. These missions will perform simultaneous and closely coordinated measurements throughout the Earth's space environment. In addition, data will be provided from existing spacecraft in orbits around the equator. Ground-based and theoretical investigations will also be conducted.

NASA is collaborating with the European Space Agency (ESA) in two additional solar-terrestrial missions, Cluster and SOHO. The Wind and Polar missions and NASA's contributions to SOHO, Cluster, and Geotail make up the ISTP Science Initiative. The aim of ISTP is to understand the physical

environment of the Earth in space and the impact of the Sun on that environment.

SCIENCE RATIONALE

Energy streams out from the Sun towards the Earth in a solar wind of electrified particles. Moving at about a million miles per hour, this hot, ionized gas — called a plasma — carries particles and magnetic fields from the Sun outward past the planets. The Earth is shielded from the direct impact of these particles by its magnetosphere, the region around the Earth dominated by its magnetic field. The existence of the solar wind was first confirmed in the early 1960s by the Mariner 2 spacecraft. Subsequent exploration of the Earth's space environment, known as geospace, has revealed a dynamic and complex system of interacting plasma, magnetic fields, and electrical currents that are greatly affected and controlled by variations in the solar wind.

NASA's Wind mission will measure properties of the solar wind as it approaches the Earth's magnetosphere. Early in the mission, Wind will take readings in the turbulent area where particles of the solar wind are reflected from a shock wave that forms as the solar wind encounters the Earth's magnetic field. This shock wave, known as the bow shock, occurs in front of the magnetosphere where the supersonic solar wind must decelerate and bend away from the compressed geomagnetic field. Later, Wind will be repositioned into a circular orbit in the solar wind upstream from the Earth. It will orbit around the L-1 Lagrangian point which is a fixed distance in the solar wind upstream of the Earth, always on the Earth-Sun line. Here, Wind will observe the solar wind before it intercepts the magnetosphere.

THE IACG AND FUTURE RESEARCH

In addition to ISTP coordination, broader planning is underway to coordinate with additional solar terrestrial missions. Under the auspices of the Inter-Agency Consultative Group for Space Science (IACG), representing ESA, the Russian Space Institute (IKI), ISAS, and NASA, a series of specific coordinated mission campaigns are being planned to study the solar terrestrial environment and its processes. These campaigns will be accomplished over the next several years when spacecraft positions are particularly favorable.

The first campaign, entitled "Magnetotail Energy Flow and the Role of Non-Linear Dynamics" has two research themes. The first is to determine the structure of the global magnetotail system, while the second is to study the dynamics of the global solar wind/magnetotail interaction. The former campaign will begin in late 1995 when data on the magnetotail will be available from Geotail and the Russian Interball mission. Data on the solar wind and its influence on the magnetosphere, provided by the Wind mission, will be used to support the latter campaign beginning in early 1995. In addition, a wide range of other resources, including data from other currently operating satellites and ground-based observations, will be used in conjunction with this campaign to understand the large-scale configuration of the Earth's magnetospheric system.

Other campaigns are planned for later in the decade after the launch of NASA's Polar mission, and ESA's Cluster and SOHO missions. One such campaign, entitled "Boundaries in Collisionless Plasma" is planned to begin in late 1996 using Polar and Cluster data. Another campaign planned for 1996 is entitled "Solar Events and their Manifestations in Interplanetary Space and in Geospace". This campaign will use data from the SOHO and Cluster missions. During all of the IACG campaigns, investigators will have access to key parameter data from multiple spacecraft, to enable enhanced coordinated event analysis from many sources of data.

MISSION SEQUENCE

Wind will be launched on a Delta II ELV from CCAS into approximately a 187 x 495,193 km (101 x 267,383 nmi) initial phasing orbit with an inclination of 28.7 degrees. The Wind Boost Profile is depicted in Figure 2. Table 1 shows the expected sequence of events from liftoff through spacecraft separation.

After 4.5 initial phasing orbits, Wind will move into a double lunar swing-by orbit with an apogee of no more than 1600,000 km (860,000 nmi) and a perigee of at least 29,000 km (15,000 nmi). The Wind spacecraft will perform ten double lunar swing-by orbits.

Approximately 2 years into the mission, Wind will be maneuvered into a small halo orbit 1,500,000-1,690,000 km (808,000-912,000 nmi) from the earth at the Lagrangian point. Wind will remain in this orbit to the conclusion of the mission.

The majority of the spacecraft activation will be performed in the first 11 days after launch, e.g. deployment of the MGA, subsystem activation/checkout, attitude acquisition, and instrument appendage deployments with the exception of the Z-Booms which will be deployed on day 18 and 19. Complete instrument activation will be completed in approximately 30 days following launch.

A Perigee Raise Maneuver (PRM) will be performed near Apogee 1 for some launch days. A TTI Correction Maneuver is required within 15 hours depending upon launch vehicle dispersions. Phasing Maneuvers at Perigee and/or Apogee will be conducted as required to achieve first lunar swing-by.

The following reflects the 30 day mission timeline for the Wind mission.

WIND 30 DAY Integrated Mission Timeline Overview

Activity Name

IMT cross-reference
 "Fixed-time" pass
 "Health & Safety" pass
 Orbital Events

Maneuvers

1. Calibration TCM
 2. Launch: 08:36 GMT
 3. Axial Thruster Calibration
 4. Attitude Acquisition Maneuvers 1, 2, 3, 4, 5
 5. Phasing Maneuvers 1, 2, 3, 4, 5

Spin Rate (rpm)

152.3
 10.0-0.1
 20.5-2

Deployments

MOA
 EESA/FESA
 WAVES Search Coil
 LDB
 Radial Wires

Telemetry Mode

△ Activate R/S Encoding
 ▽ Activation
 ▽ = Convolutional Mode

EPACT

ELITE
 LBMT
 STEP

TGRS

Bake-out Heater on
 TGRS ON
 TGRS OFF
 Bake-out HTR ON (for 30 min.) Then OFF
 HV ON & HV Ramp Up
 HV Phase A
 HV Phase B
 HV Phase C

WAVES

Power Enable & Open Door
 Power On
 Activate

3D-PLASMA

Power On & Covers ON
 Activation

SWE

Test Cycles 1 & 2
 Test Cycle 3
 Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Activate
 On/Off 10 Hz
 On/Off 10 Hz

STICS

Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Activate
 On/Off 10 Hz
 On/Off 10 Hz

SWICS

Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Activate
 On/Off 10 Hz
 On/Off 10 Hz

MASS

Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Activate
 On/Off 10 Hz
 On/Off 10 Hz

KONUS

Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Power On/Off Open
 Covers/LV Check Out
 Activate
 On/Off 10 Hz
 On/Off 10 Hz

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Figure 2.

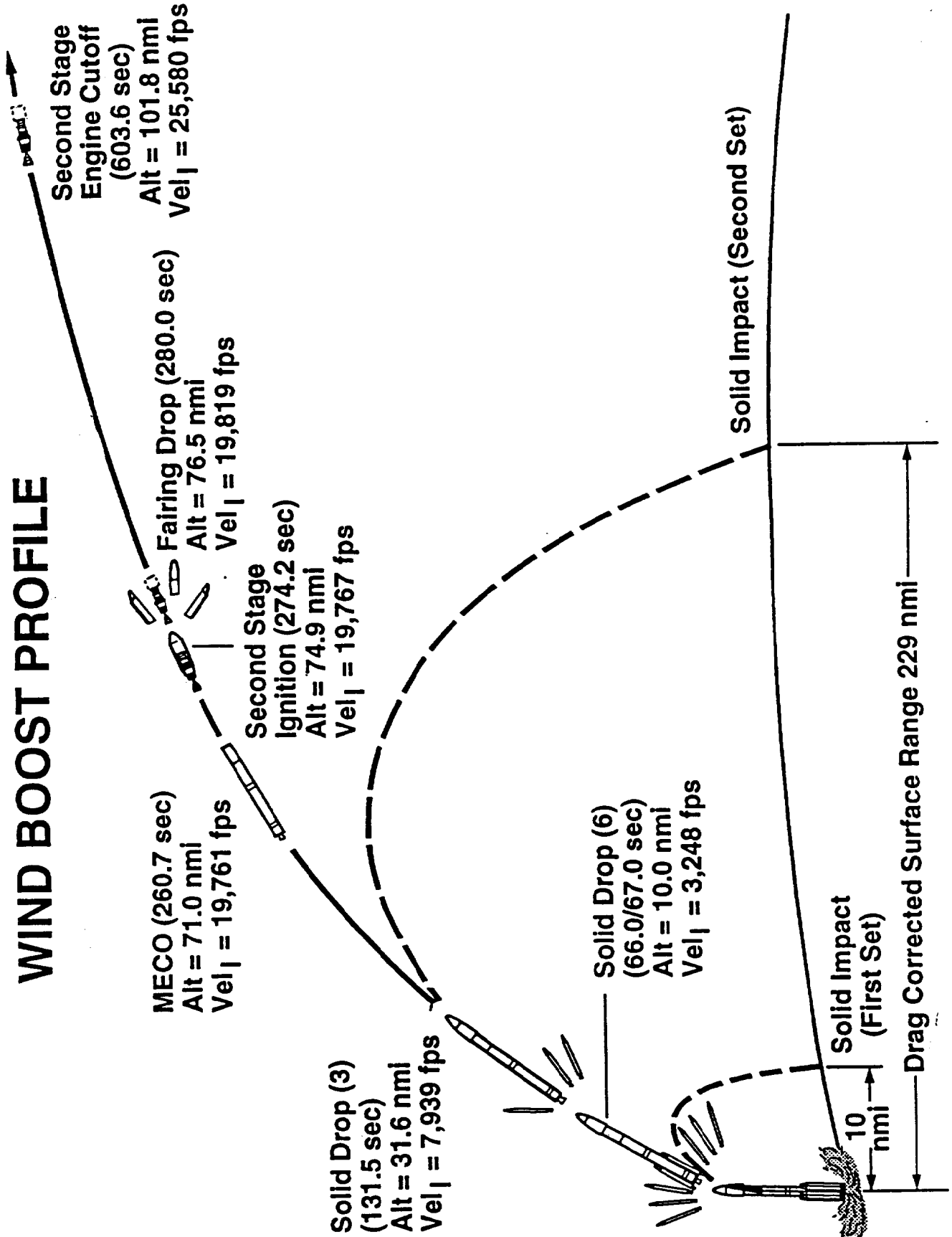


Table 1. Launch Vehicle Sequence of Events

| Event | Time (seconds) |
|---|-------------------|
| Liftoff | 0.0 |
| Mach 1 | 32.5 |
| Maximum Dynamic Pressure | 47.4 |
| 6 Solid Motors Burnout | 63.1 |
| 3 Solid Motors Ignition | 65.5 |
| Jettison 3 Solid Motors | 66.0 |
| Jettison 3 Solid Motors | 67.0 |
| 3 Solid Motors Burnout | 128.8 |
| Jettison 3 Solid Motors | 131.5 |
| Main Engine Cutoff (MECO) | 260.7 |
| Stage I-II Separation | 268.7 |
| Stage II Ignition | 274.2 |
| Fairing Jettison | 280.0 |
| First Cutoff-Stage II (SECO 1) | 603.6 |
| Begin Reorientation Maneuver | 700.0 |
| End Reorientation Maneuver | 915.0 |
| Begin Slow Roll | 920.0 |
| End Slow Roll | 4050.0 |
| Stage II Restart Ignition | 4315.0 |
| Second Cutoff-Stage II (SECO 2) | 4400.5 |
| Fire Spin Rockets | 4450.5 |
| Stage II-III Separation | 4453.5 |
| Stage III Ignition-Nutation Control System Enable | 4490.5 |
| Stage III Burnout (TECO) | 4877.7 |
| Disable NCS - Initiate Despin | 4860.5 |
| Despin Complete | 4864.3 |
| Spacecraft Separation | 4865.5 |
| Stage II Depletion Burn Ignition | 5700.0 |
| Stage II Depletion Burn Cutoff | 5715.0 |

WIND SPACECRAFT DESCRIPTION

The Wind spacecraft is a spin-stabilized cylinder-shaped spacecraft measuring 2.44 meters (7.87 ft) in diameter and 1.88 meters (5.91 ft) in height. The wet weight of the spacecraft is approximately 1,250 kg. Hydrazine propellant is used for orbit and attitude control. The design life of the Wind spacecraft is three years. Figure 3 shows the Wind spacecraft in its operational configuration followed by the spacecraft/instrument layout.

The Wind spacecraft has two pairs of radial wire antennas for the Waves experiment. One pair is 50 meters long from base to tip, and the second pair is approximately 7.5 meters long. There are two lanyard booms 12 meters in length on which are mounted the Magnetic Field Investigation (MFI) magnetometers and the Waves Search Coils. The Electron Electrostatic Analyzer (EESA) and Proton Electrostatic Analyzer (PESA) sensors for the 3-D Plasma investigation are mounted on two radial booms measuring 0.5 m in length.

The Power Subsystem consists of twelve body-mounted solar array panels, Power Supply Electronics (PSE), Battery Charge Assembly (BCA), three nickel cadmium batteries (26.5 Amp-Hr each), and sequential shunt dissipater elements. The solar cell arrangement has an area of 11.5 m² (124 ft²) and contains a cylindrical array. Total end of life available power (in the halo orbit) for spacecraft operations will be 367 watts. The beginning of life average generating power will be 473 watts.

The Communications Subsystem consists of a deployable medium gain antenna, two low-gain, hemispheric beam transmitting antennas (one on each end of the spacecraft), and two low-gain, hemispheric beam receiving antennas (also on each end of the spacecraft). The hemispheric antennas provide 4 pi steradian coverage for commanding and low-rate spacecraft telemetry. In normal mission operations, all commanding, metric tracking, and data acquisition are accomplished via the medium gain antenna. The radio frequency equipment is S-band and compatible with the Jet Propulsion Laboratory/Deep Space Network (JPL/DSN). Power amplifiers are used to support high data rate tape recorder playback. Instrument science data and housekeeping data will be recorded on-board and dumped periodically at a high rate during scheduled DSN station contacts.

The Command and Data Handling (C&DH) Subsystem consists of two Command and Attitude Processors (CAP 1 and 2), an Internally redundant GGS Telemetry Module (GTM 1 and 2), two Digital Tape Recorders (DTR A and B), an Internally redundant Command Distribution Unit (CDU 1 and 2), an internally Redundant Crystal Oscillator (RXO prime and backup), and a Pyrotechnic Relay Assembly (PRA). This system executes all laboratory commands through either real-time or stored commands, as well as processes

and stores all spacecraft telemetry and instrument data for DTR playback or real-time downlink through the Communications Subsystem.

The Attitude Control and Determination Subsystem (ACADS) consists of two Sun Sensor Assemblies (SSA), two Horizon Sensor Assemblies (HSA), spin and nutation damper assemblies, an accelerometer unit, and a star scanner assembly. The passively spin-stabilized laboratory uses the attitude sensors to determine position and spin phase and the dampers to eliminate oscillations. The Wind laboratory maintains a 20-rpm (2.1 rad/s) spin rate with its spin axis normal to the ecliptic plane. All orbit adjustments are performed by the propulsion subsystem.

The Propulsion Subsystem consists of six 0.56-meter (1.8 ft) diameter tanks, eight 22-N and four 2.2-N hydrazine Reaction Engine Assemblies (REA), and associated valving and harnessing. The spacecraft tankage is capable of holding a maximum of 395 kg (871 lbs) of hydrazine propellant. This system performs all post-launch orbit acquisition and adjustment functions.

The Structural subsystem consist of a center column, two equipment decks, six shear panels, stringers, top and bottom closure panels, etc. All structural panels are fabricated from aluminum face sheets and honeycomb core. The center column is magnesium with aluminum rings at the critical interfaces. The Wind cylindrical structure has a payload mounting area of 9.3 m² (100 ft²). Thermal control is provided by multilayer insulation blankets , passive radiators, and is augmented with electrical heaters.

Wind Laboratory

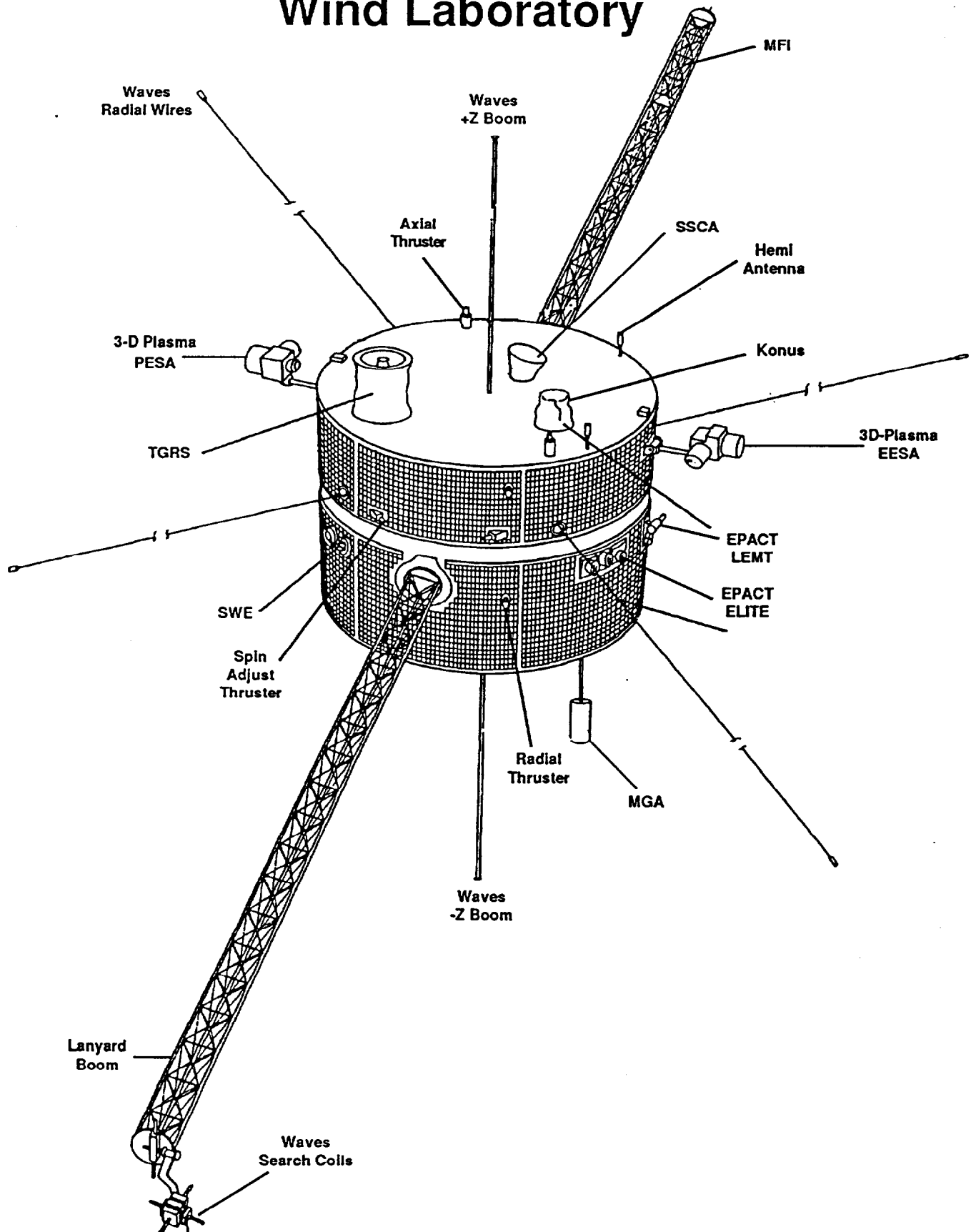


Figure 3. Wind Spacecraft

EXPERIMENT DESCRIPTIONS

The Wind spacecraft will carry the following complement of eight investigations. These are:

1. Radio and Plasma Waves (Waves)
2. Solar Wind Experiment (SWE)
3. Magnetic Field Investigation (MFI)
4. Energetic Particle Acceleration, Composition, and Transport (EPACT)
5. Solar Wind and Suprathermal Ion Composition and Mass Sensor (SMS)
6. Three-Dimensional Plasma and Energetic Particle Analyzer (3-D Plasma)
7. Transient Gamma Ray Spectrometer (TGRS)
8. Russian Gamma Ray Spectrometer (Konus)

The following provides an overview, scientific objectives, and general description of each of these individual investigations.

RADIO AND PLASMA WAVE EXPERIMENT (WAVES)

EXPERIMENT OVERVIEW

The Sun and the Earth emit radio waves that affect particles in the interplanetary plasma and carry some of the energy flowing there. The WAVES experiment will measure the properties of these waves and other wave modes of the plasma over a wide frequency range. Analyses of these measurements, in coordination with the other onboard plasma, energetic particles, and field measurements, will further the understanding of solar wind and interplanetary plasma processes.

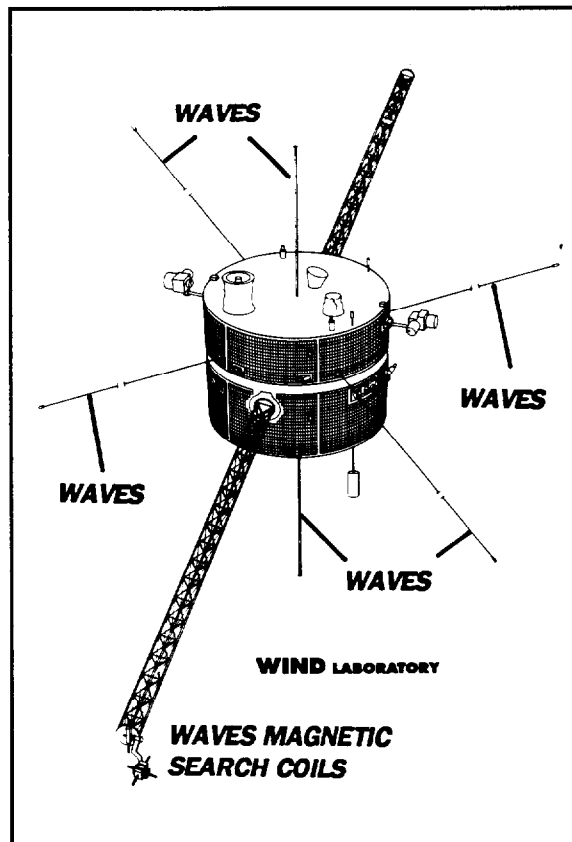
SCIENCE OBJECTIVES

To provide comprehensive measurements of the radio and plasma wave phenomena which occur in the solar wind upstream of the Earth's magnetosphere and in key regions of the magnetosphere.

MEASUREMENT OBJECTIVES

To obtain the following measurements:

- Low-frequency electric waves and low-frequency magnetic fields, from DC to 10 kHz.
- Electron thermal noise, from 4 kHz to 256 kHz.
- Radio waves, from 20 kHz to 14 MHz.
- Time-domain waveform sampling, to capture short duration events which meet quality criteria set into the WAVES data processing unit (DPU).



DESCRIPTION OF INSTRUMENT

The sensor system of the WAVES experiment consists of three electric antenna systems (two coplanar, orthogonal wire antennas in the spin-plane and a rigid spin-axis dipole) and a triaxial magnetic search coil. The longer and shorter spin-plane dipoles have lengths of 50 m and 7.5 m for each wire, respectively, while each spin-axis dipole extends 5.28 m from the top and bottom surfaces of the spacecraft. The triaxial magnetic search coil for measuring low-frequency magnetic fields is mounted at the outboard end of a 12-m radial boom. There are five main receiver systems: a low frequency (DC to 10 kHz) Fast Fourier Transform receiver, a broadband (4 kHz to 256 kHz) electron thermal noise receiver, two swept-frequency radio receivers (20 kHz to 1MHz, and 1MHz to 14 MHz), and a time-domain waveform sampler (up to 120,000 samples per second). The DPU controls and acquires data from all operations of the experiment, and can be reprogrammed from the ground. The receiver systems and DPU are housed within the spacecraft body. WAVES has onboard interconnects with 3-D PLASMA and with SWE.

INSTRUMENT RESOURCES

- Weight (kg): 43.58
- Power (Watts ave.): 28.0
- Telemetry (kbps): .937

PRINCIPAL INVESTIGATOR

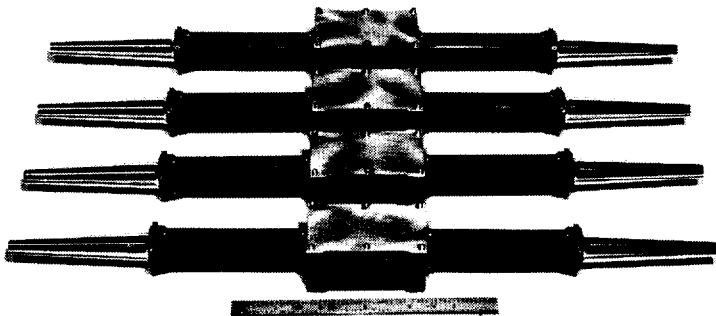
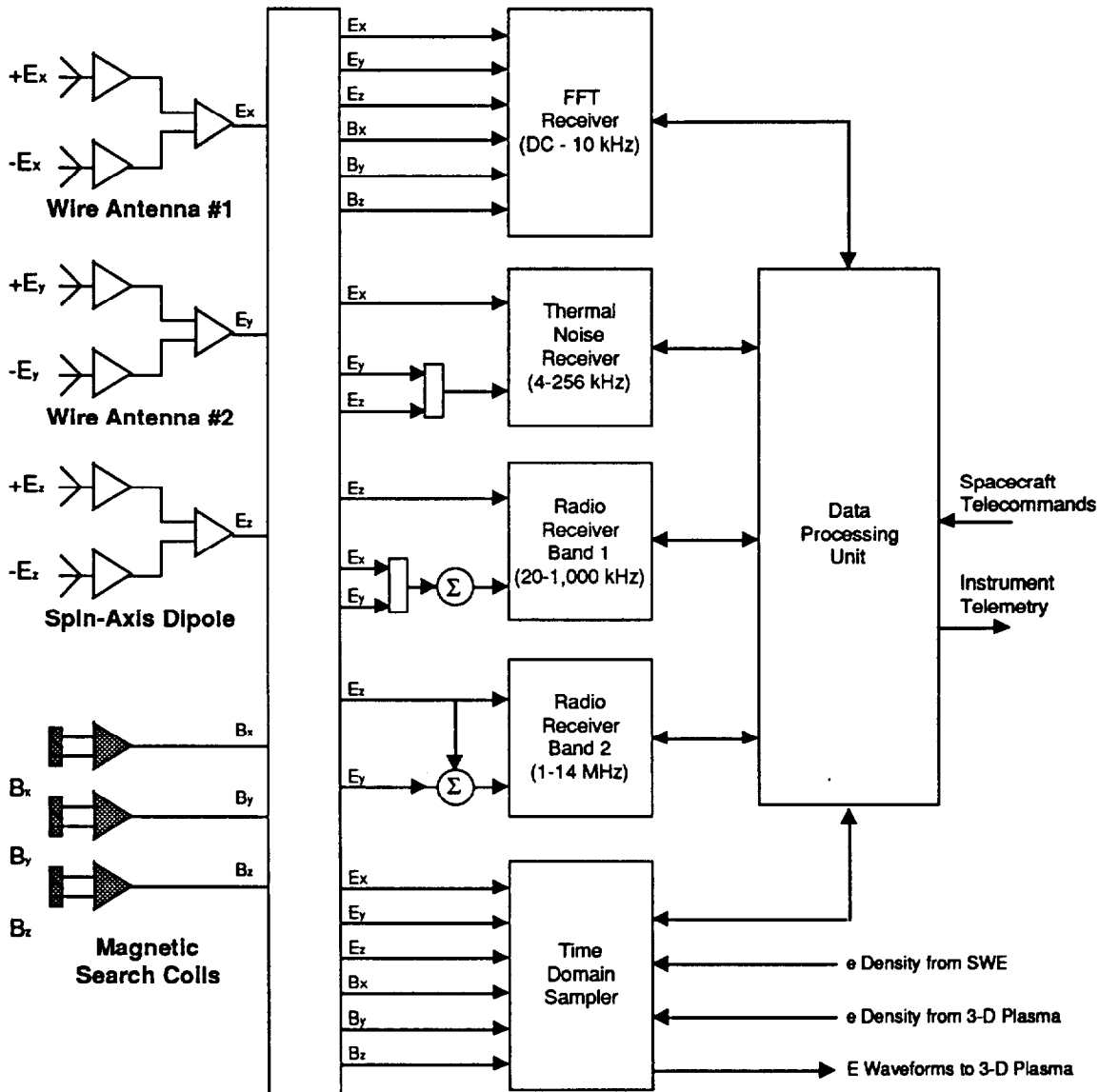
Dr. J.-L. Bougeret
Laboratoire de Recherche Spatiale
Observatoire de Paris-Meudon
92195 Meudon Cedex, France

GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

WIND SPACECRAFT INSTRUMENTATION

RADIO AND PLASMA WAVE EXPERIMENT (WAVES)

OVERALL BLOCK DIAGRAM



Waves Magnetic Search Coils. Each unit is 16 inches (40.6 cm) in length. Three of these coils are mounted at the end of the Waves Extendable Boom in x, y, and z orientations.

SOLAR WIND EXPERIMENT (SWE)

EXPERIMENT OVERVIEW

SWE will measure ions and electrons in the solar wind and the foreshock regions (particles whose energies are in the kiloelectronvolt range). From these measurements, the solar-wind velocity, density, temperature and heat flux can be deduced. Electron and ion velocity distributions should reveal properties of the flowing plasmas and their pivotal role in the transfer of mass, momentum, and energy from the Sun to the Earth. Measurements made in the foreshock region will contribute to understanding the structure of the bow shock.

SCIENCE OBJECTIVES

To study the solar wind and its fluctuations and the interaction of the solar wind with the magnetospheric system.

MEASUREMENT OBJECTIVES

To provide:

- High time-resolution 3-D velocity distributions of the ion component of the solar wind, for ions with energies ranging from 200 eV to 8.0 keV.
- High time-resolution 3-D velocity distributions of subsonic plasma flows including electrons in the solar wind and diffuse reflected ions in the foreshock region, with energies ranging from 7 eV to 22 keV.
- High angular-resolution measurements of the "strahl" (beam) of electrons in the solar wind, along and opposite the direction of the interplanetary magnetic field, with energies ranging from 5 eV to 5 keV.

DESCRIPTION OF INSTRUMENT

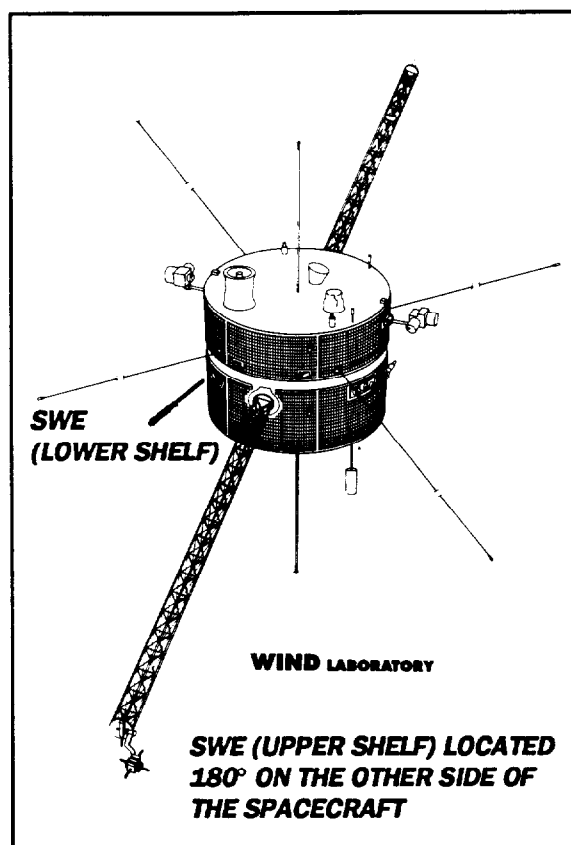
The SWE instrument consists of five integrated sensor/electronics boxes and a data processing unit (DPU). The sensor units are mounted on the top and bottom shelves of the spacecraft, extending through the top and bottom surfaces. 3-D velocity distribution measurements of the ion component in the solar wind are made by a pair of Faraday Cup analyzers, which provide a wide field-of-view and the capability for flow characterization within one spin revolution (3 seconds). 3-D velocity distribution measurements of ions and electrons in plasmas having Mach numbers <1 are made using six cylindrical electrostatic deflection analyzers, called Vector Electron and Ion Spectrometers (VEIS), arranged in two triaxial sets. A toroidal electrostatic analyzer with channelplate detectors functions as the strahl sensor, measuring electron velocity distribution and pitch angle. An ultra-violet calibration unit for the VEIS is mounted inside the spacecraft with the DPU.

INSTRUMENT RESOURCES

- Weight (kg): 16.7
- Power (Watts ave.): 13.5
- Telemetry (kbps): .600

PRINCIPAL INVESTIGATOR

Dr. K. Ogilvie
NASA/ Goddard Space Flight Center
Head of Interplanetary Physics Branch
Code 692
Greenbelt, Maryland 20771

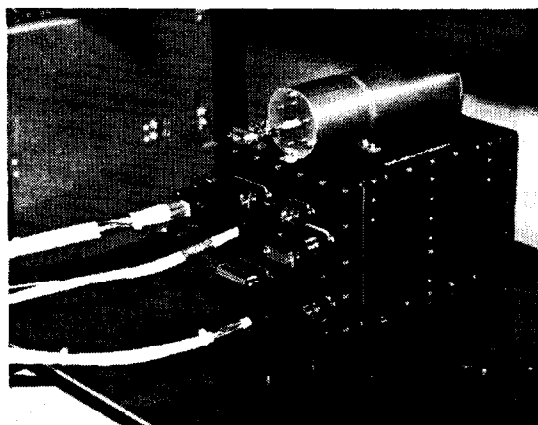
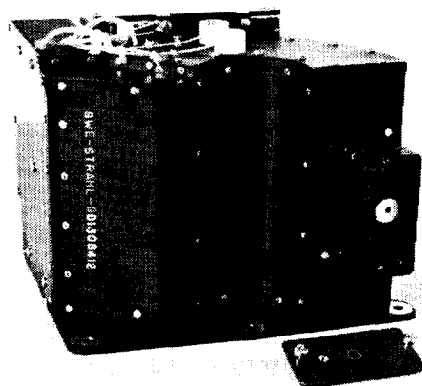
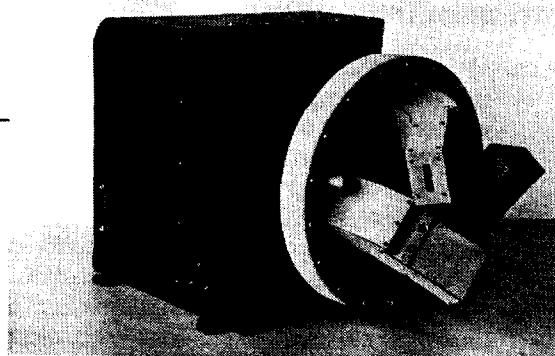
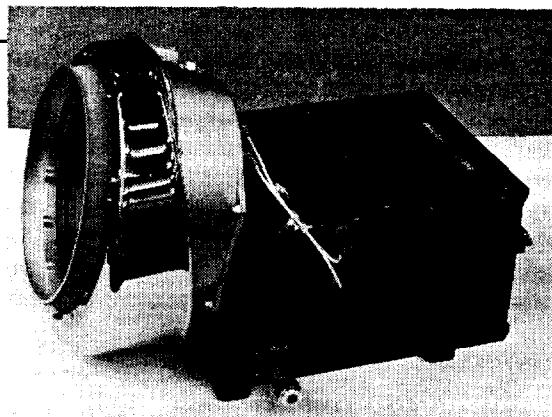
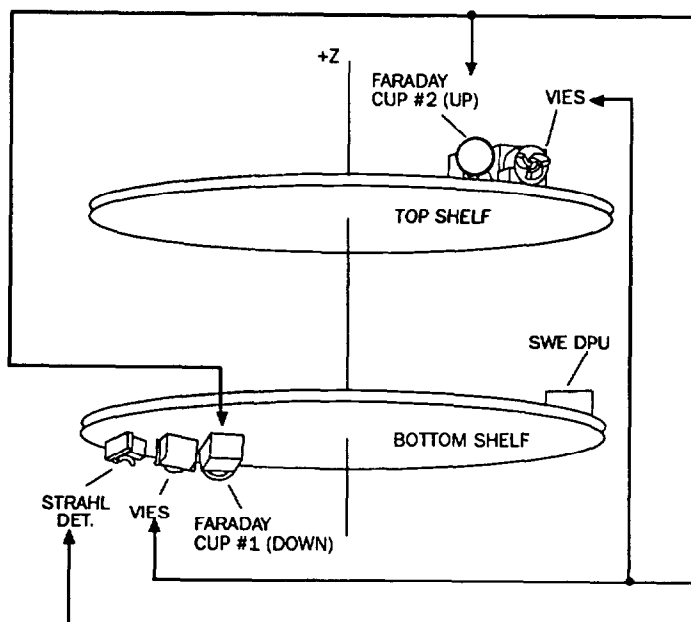


GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

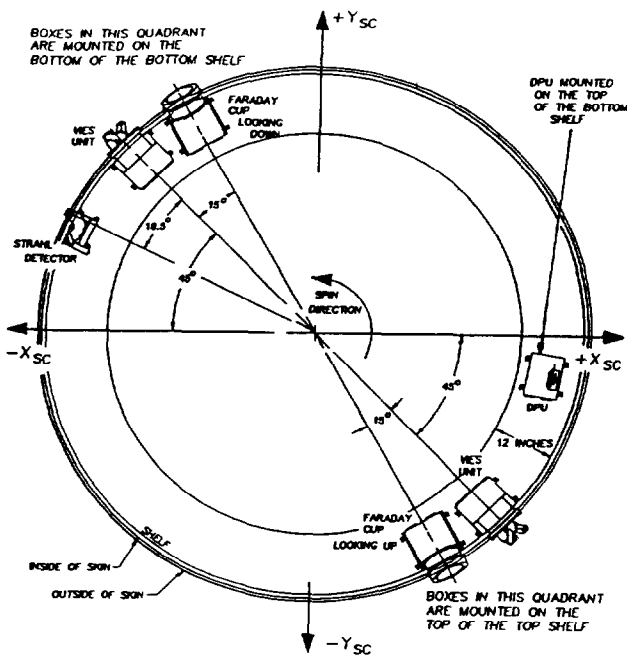
WIND SPACECRAFT INSTRUMENTATION

SOLAR WIND EXPERIMENT (SWE)

INSTRUMENT COMPONENTS AND PLACEMENT



**DATA PROCESSING UNIT (DPU)
AND UV CALIBRATION UNIT**



**RELATIVE ANGULAR LOCATION OF THE INSTRUMENTS
MOUNTED ON THE EXPERIMENT SHELVES**

MAGNETIC FIELD INVESTIGATION (MFI)

EXPERIMENT OVERVIEW

MFI will investigate the large-scale structure and fluctuation characteristics of the interplanetary magnetic field, which influence the transport of energy and the acceleration of particles in the solar wind and dynamic processes in the Earth's magnetosphere. The fundamental observations of solar wind magnetic fields are important to the study of the solar wind and magnetosphere coupling process and also to the interpretation of other observational data from WIND.

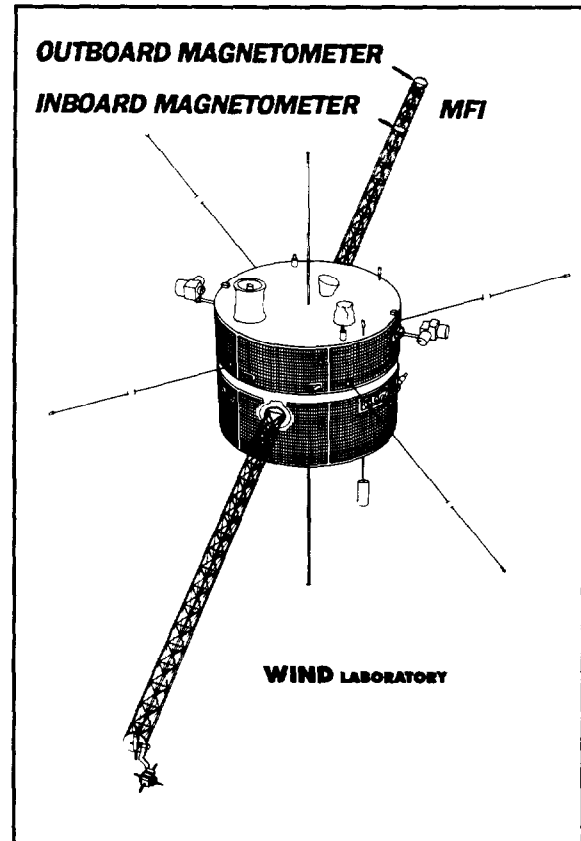
SCIENCE OBJECTIVES

To establish the large-scale structure and fluctuation characteristics of the interplanetary magnetic field as functions of time, and through correlative studies to relate them to the dynamics of the magnetosphere.

MEASUREMENT OBJECTIVES

To provide:

- Accurate, high-resolution vector magnetic field measurements in near real time on a continuous basis.
- A wide dynamic measuring range, from ± 0.004 nT up to $\pm 65,536$ nT, in eight discrete range steps.
- Measurement rates up to 44 vector samples per second for analysis of fluctuations.



DESCRIPTION OF INSTRUMENT

The MFI instrument consists of dual triaxial fluxgate magnetometers mounted on a 12-meter radial boom, and a data processing and control unit within the body of the spacecraft. The magnetometer sensors each produce analog signals proportional to the strength of the magnetic field component aligned with the sensor. These signals are then digitized and processed by a microprocessor-controlled data system. Mounting the magnetometers at the outboard end and at an inboard location on the boom helps substantially to reduce contamination of the measurements by spacecraft-generated magnetic fields. MFI has a very wide field measurement capability, from ± 0.004 nT to $\pm 65,536$ nT, with both automatic and commandable range-change capability. Measurement rates are: one vector per 92 seconds for key parameter data, 10.9 vectors per second for rapid data for standard analysis, and 44 vectors per second for Fast Fourier Transform data, and data from the snap-shot memory which can be triggered automatically for pre-defined field changes.

INSTRUMENT RESOURCES

- Weight (kg): 2.55
- Power (Watts ave.): 2.40
- Telemetry (kbps): .485

PRINCIPAL INVESTIGATOR

Dr. R. Lepping
NASA/ Goddard Space Flight Center
Interplanetary Physics Branch
Code 695
Greenbelt, Maryland 20771

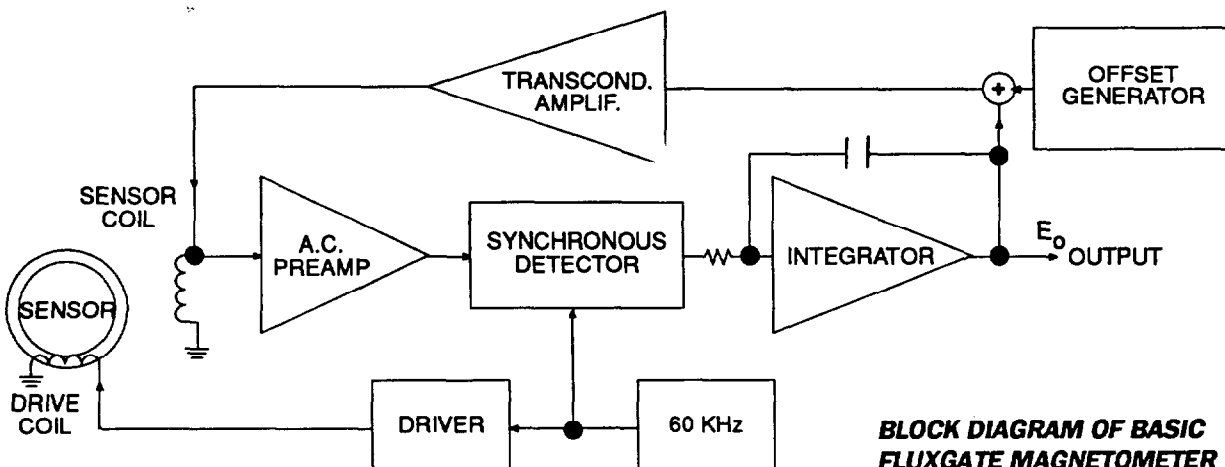
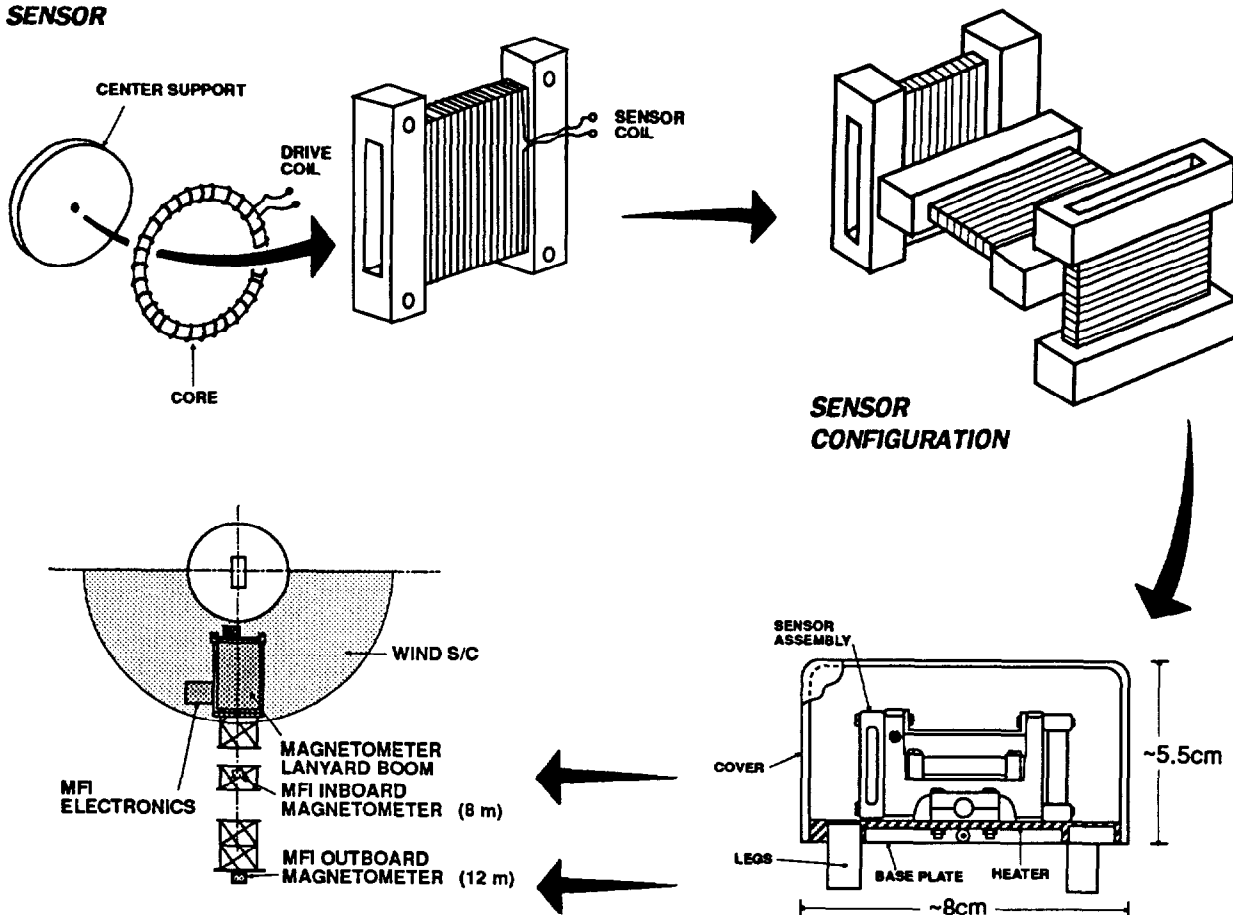
GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

WIND SPACECRAFT INSTRUMENTATION

MAGNETIC FIELD INVESTIGATION (MFI)

INSTRUMENT COMPONENTS

SENSOR



BLOCK DIAGRAM OF BASIC FLUXGATE MAGNETOMETER

ENERGETIC PARTICLE ACCELERATION, COMPOSITION AND TRANSPORT (EPACT)

EXPERIMENT OVERVIEW

The EPACT investigation will provide a comprehensive study of energetic particle acceleration and transport processes in solar flares, the interplanetary medium, and planetary magnetospheres, as well as the galactic cosmic rays and the anomalous cosmic ray component. EPACT measurements will determine elemental and isotopic abundances for the minor ions making up the solar wind, with energies in excess of 20 keV. This direct sampling of solar matter is a way to study events on the solar surface and the incorporation of solar material into the solar wind. EPACT will also provide information on shocks in the interplanetary medium, which accelerate particles from solar-wind energies to several hundred keV.

SCIENCE OBJECTIVES

To study acceleration, composition and transport of energetic particle populations, including particles from solar flares, particles accelerated in interplanetary shocks, and the anomalous component and galactic cosmic rays.

MEASUREMENT OBJECTIVES

To provide:

- Energy spectra of electrons and atomic nuclei of different charge and isotopic composition, from hydrogen to iron, over an energy range extending from 0.1 to 500 MeV/nucleon.
- Isotopic composition of medium energy particles (2 - 50 MeV/nucleon) in solar flares, in the anomalous component and in galactic cosmic rays, extending up to $Z = 90$.
- Determination of angular distributions of these fluxes.

DESCRIPTION OF INSTRUMENT

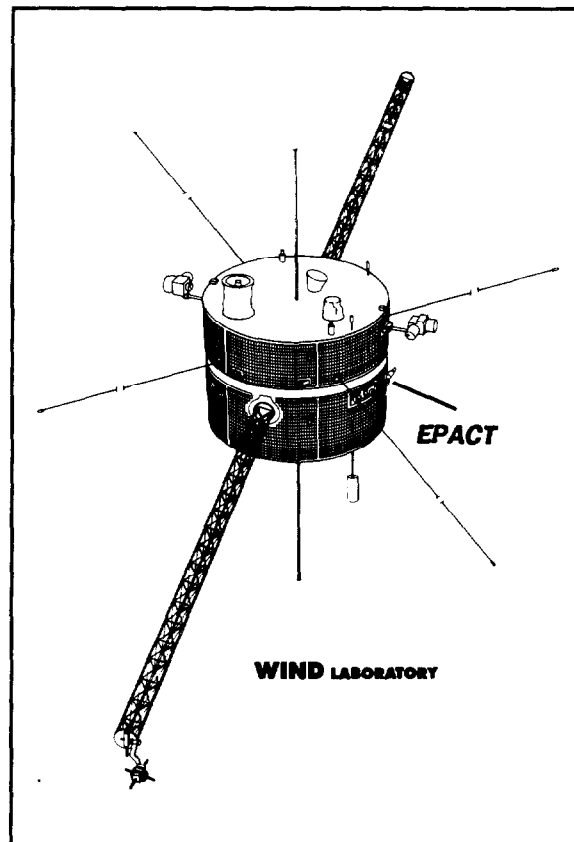
The EPACT instrument consists of three integrated telescope/electronics boxes mounted on the body of the spacecraft. The extensive dynamic range of particles to be measured is divided between three Low Energy Matrix Telescopes (LEMT), two Alpha-Proton-Electron Telescopes (APE), an Isotope Telescope (IT), and a Supra Thermal Energetic Particle Telescope (STEP). The APE and IT instruments are contained in a single package known as the Electron Isotope Telescope (ELITE). These solid state detector telescopes all use the dE/dx by E method of particle identification, except STEP, which obtains particle mass by measuring time-of-flight and energy. An onboard recorder allows continuous observations to be made.

INSTRUMENT RESOURCES

- Weight (kg): 30.78
- Power (Watts ave.): 20.07
- Telemetry (kbps): .468

PRINCIPAL INVESTIGATOR

Dr. T. von Rosenvinge
NASA/ Goddard Space Flight Center
Nuclear Astrophysics Branch
Code 661
Greenbelt, Maryland 20771

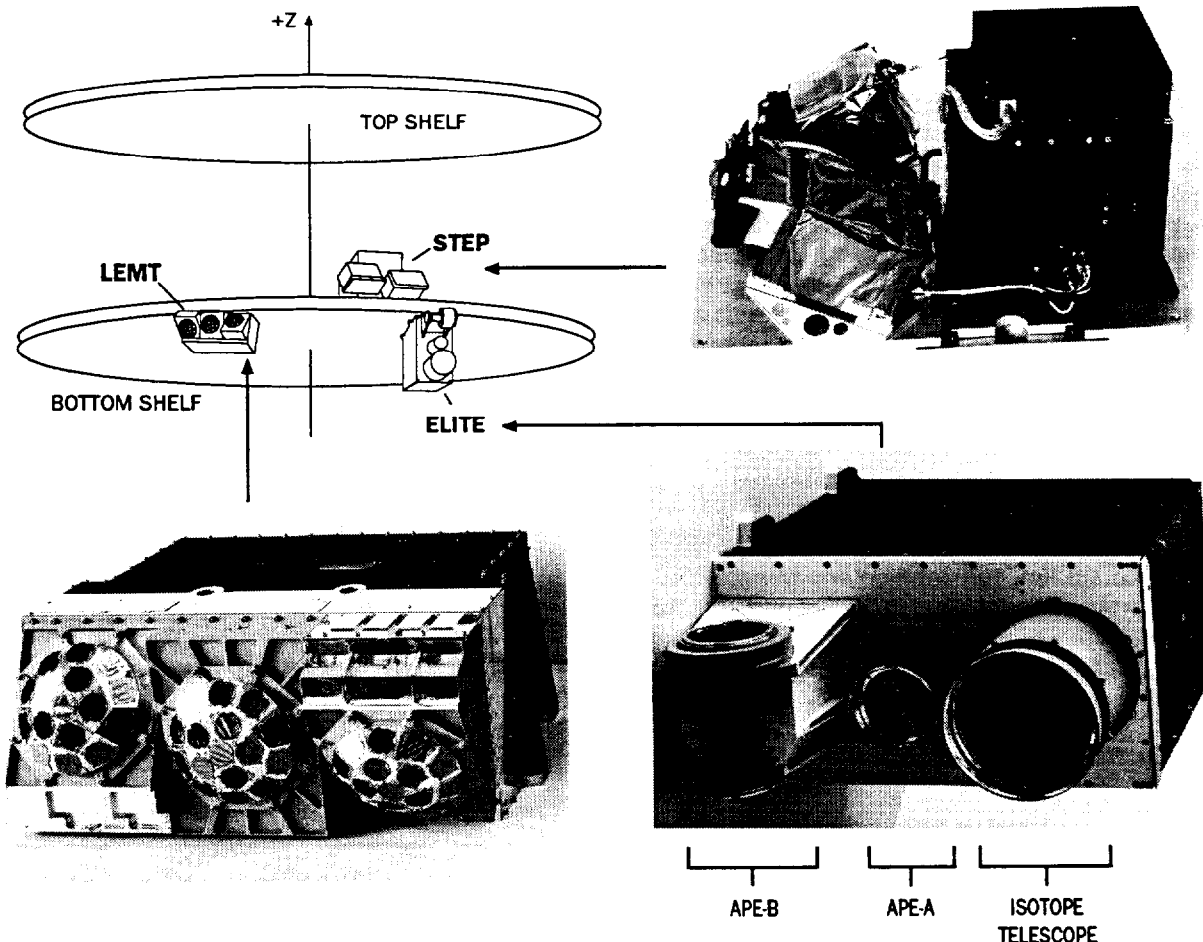


GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

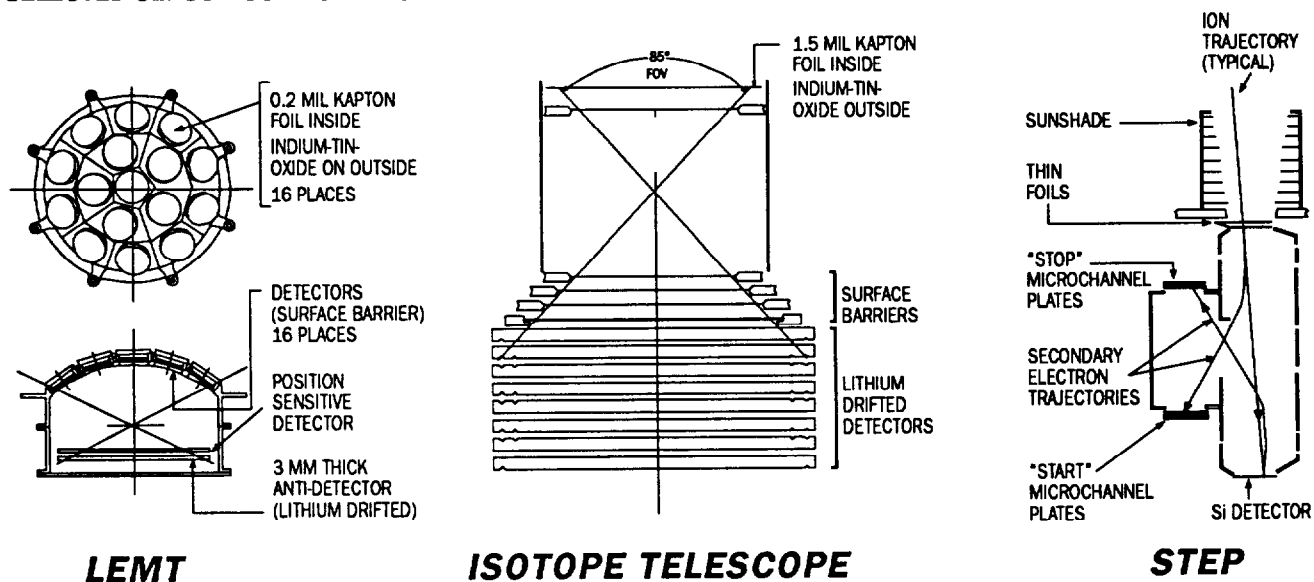
WIND SPACECRAFT INSTRUMENTATION

ENERGETIC PARTICLE ACCELERATION, COMPOSITION AND TRANSPORT (EPACT)

INSTRUMENT COMPONENTS AND PLACEMENT



SELECTED SENSOR COMPONENTS



SOLAR WIND AND SUPRATHERMAL ION COMPOSITION EXPERIMENT (SMS)

EXPERIMENT OVERVIEW

The SMS experiment comprises three major instruments: Solar Wind Ion Composition Spectrometer (SWICS), High Mass Resolution Spectrometer (MASS), and Suprathermal Ion Composition Spectrometer (STICS). This experiment will determine the abundance, composition and differential energy spectra of solar wind ions, and the composition, charge state and 3-D distribution functions of suprathermal ions. These ions and their abundance fluctuations provide information about events on the solar surface and the formation of the solar wind, complementing the EPACT and 3D-PLASMA investigations.

SCIENCE OBJECTIVES

To provide the instantaneous characteristics of matter entering the Earth's magnetosphere, determine solar abundances, characterize physical properties of the acceleration regions in the lower corona, and study the following processes: physical processes in the solar atmosphere, plasma processes affecting solar wind kinetic properties, solar wind acceleration, interplanetary acceleration mechanisms, and interstellar ion pick-up processes.

MEASUREMENT OBJECTIVES

To obtain the following measurements:

- Energy, mass and charge composition of major solar wind ions from H to Fe, over the energy range from 0.5 to 30 keV/e. (SWICS)
- High mass-resolution elemental and isotopic composition of solar wind ions from He to Ni, having energies from 0.5 to 12 keV/e. (MASS)
- Composition, charge state and 3-D distribution functions of suprathermal ions (H to Fe) over the energy range from 8 to 230 keV/e. (STICS)

DESCRIPTION OF INSTRUMENT

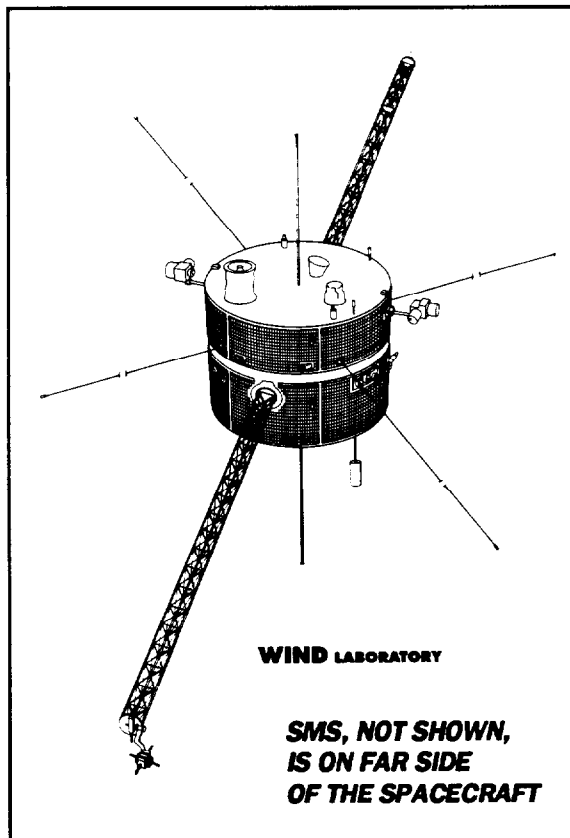
The SMS experiment consists of five separate packages mounted on the spacecraft body. SWICS uses electrostatic deflection, post-acceleration, and a time-of-flight vs. energy measurement to determine the energy and elemental charge state composition of solar wind ions. MASS uses energy/charge analysis followed by a time-of-flight measurement, to determine solar-wind ion composition with high mass-resolution ($M/\Delta M > 100$), for the first time. STICS, similar to SWICS but not using post-acceleration, has a large geometric factor and wide-angle viewing for studies of suprathermal ions. The SMS data processing unit and STICS analog electronics unit are mounted separately.

INSTRUMENT RESOURCES

- Weight (kg): 27.13
- Power (Watts ave.): 19.9
- Telemetry (kbps): .870

PRINCIPAL INVESTIGATOR

Dr. G. Gloeckler
Inst. of Physical Sciences and Technology
University of Maryland
College Park, Maryland 20942

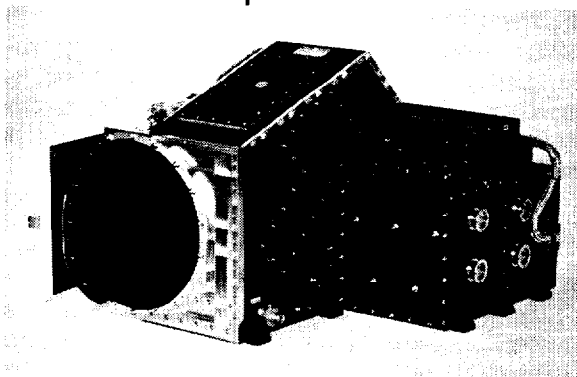
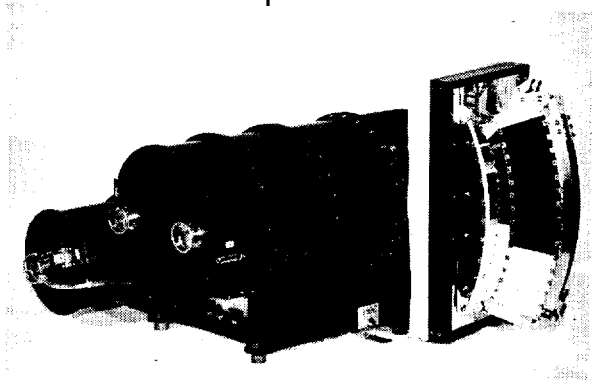
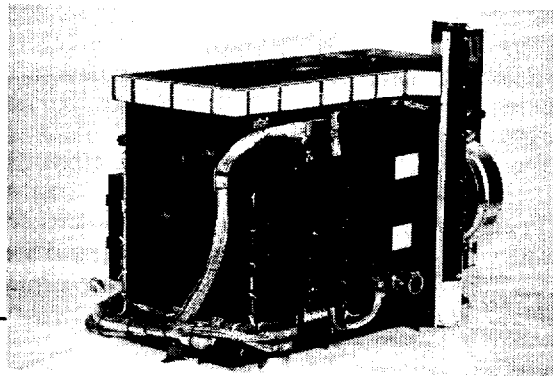
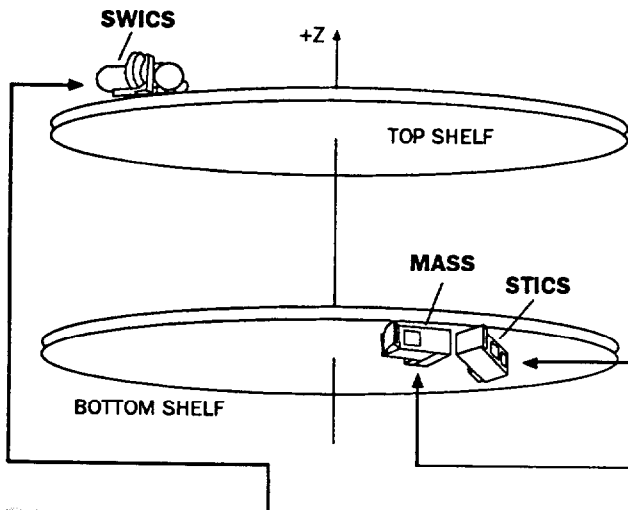


GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

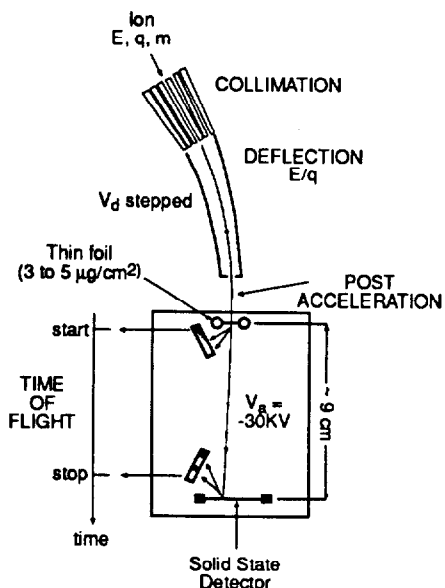
WIND SPACECRAFT INSTRUMENTATION

SOLAR WIND AND SUPRATHERMAL ION COMPOSITION EXPERIMENT (SMS)

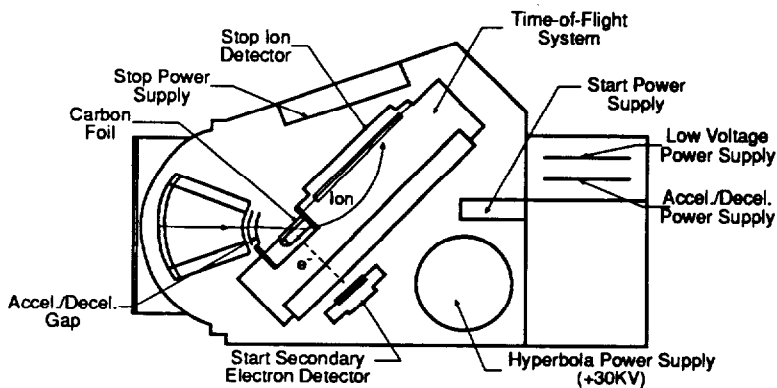
INSTRUMENT COMPONENTS AND PLACEMENT



SELECTED SENSOR COMPONENTS



SWICS AND STICS



MASS SENSOR

Note: SWICS and STICS use the same basic measurement technique, but STICS does not require post-acceleration.

3-D PLASMA AND ENERGETIC PARTICLE ANALYZER

EXPERIMENT OVERVIEW

The 3-D PLASMA investigation will measure ions and electrons in the interplanetary medium with energies including that of the solar wind and into the energetic particle range. It will study particles upstream of the bow shock in the foreshock region and the transient particles emitted by the Sun during solar particle events following solar flares. This experiment will cover the gap between the energy ranges covered by SWE and EPACT.

SCIENCE OBJECTIVES

To explore the interplanetary particle population in the thermal and suprathermal energy range, to study the particle acceleration at the Sun, in the interplanetary medium, and upstream from the Earth, to study transport of particles and basic plasma processes in the interplanetary medium, and to measure the particle and plasma input to and output from the Earth's magnetosphere.

MEASUREMENT OBJECTIVES

To obtain the following measurements:

- The three-dimensional distribution of plasma and energetic electrons and ions over the particle energy range from solar wind to cosmic ray energies, a few eV to several MeV.
- Energy resolution of 0.20 ($\Delta E/E$) and angular resolution of $5.6^\circ \times 5.6^\circ$, for particles from 3 eV to 30 keV; and energy resolution of 0.3 ($\Delta E/E$) and angular resolution of $22.5^\circ \times 36^\circ$, for particles from 20 keV to 11 MeV.
- Perturbations to the electron distribution function, in wave-particle interactions.

DESCRIPTION OF INSTRUMENT

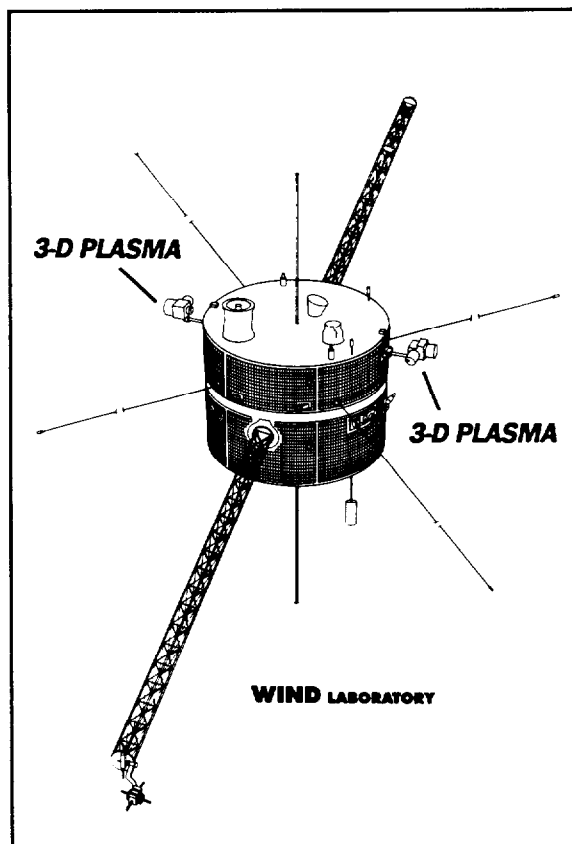
The 3-D PLASMA instrument consists of two sensor packages mounted on small radial booms, and an electronics package mounted inside the spacecraft. One boom-mounted sensor package contains an array of 6 double-ended semiconductor telescopes, each with two or three closely sandwiched silicon detectors to measure electrons and ions above 20 keV. One side of each telescope is covered with a thin foil which absorbs ions below 400 keV. On the other side, the incoming electrons below 400 keV are swept away by a magnet so that electrons and ions are cleanly separated. Higher energy electrons (up to ~1 MeV) and ions (up to 11 MeV) are identified by the two double-ended telescopes which have a third detector. The first sensor package also contains a pair of ion electrostatic analyzers (PESA-L and -H) for measuring ion fluxes from ~3 eV to 40 keV. The second sensor package contains a pair of electron electrostatic analyzers (EESA-L and -H) for measuring electron fluxes from ~3 eV to 30 keV, and for making input (from EESA-H) to a fast particle correlator (FPC). The FPC, using also plasma wave data from WAVES as input, measures perturbations to the electron distribution function and studies other wave-particle interactions.

INSTRUMENT RESOURCES

- Weight (kg): 18.19
- Power (Watts ave.): 15.4
- Telemetry (kbps): 1.0

PRINCIPAL INVESTIGATOR

Dr. R. Lin
Space Sciences Laboratory
University of California
Berkeley, California 94720

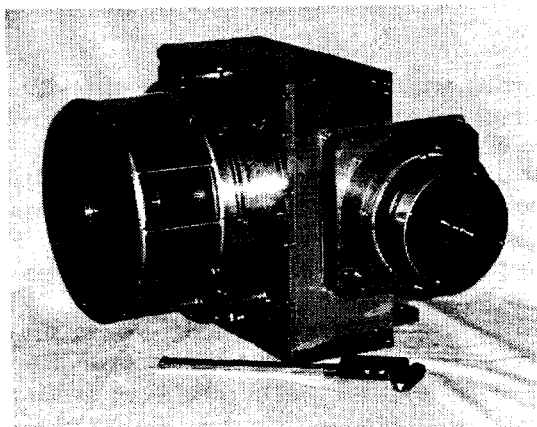
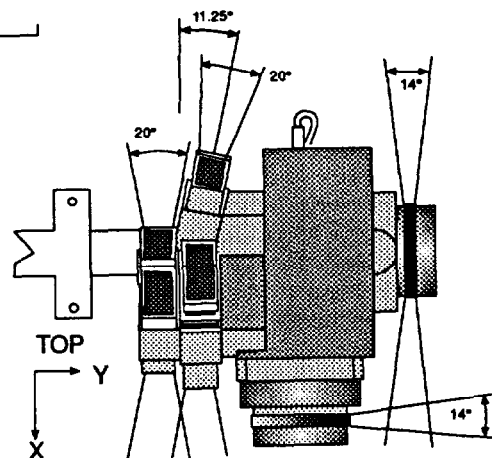
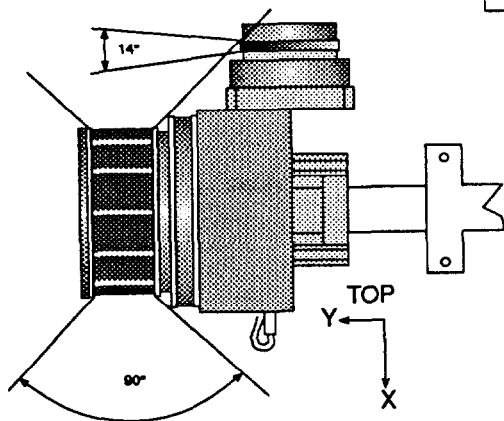
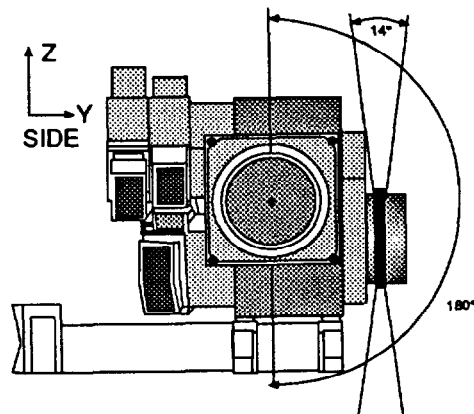
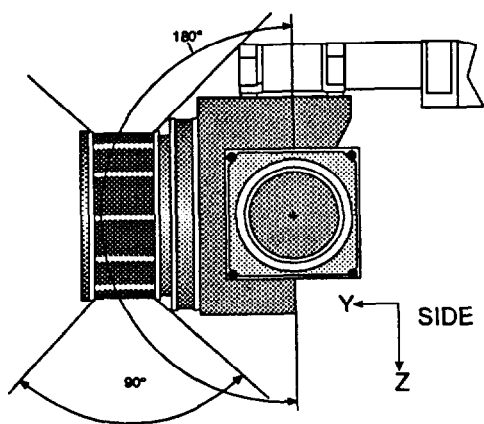


GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

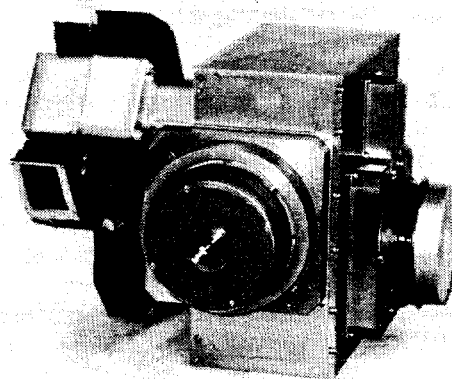
WIND SPACECRAFT INSTRUMENTATION

3-D PLASMA AND ENERGETIC PARTICLE ANALYZER

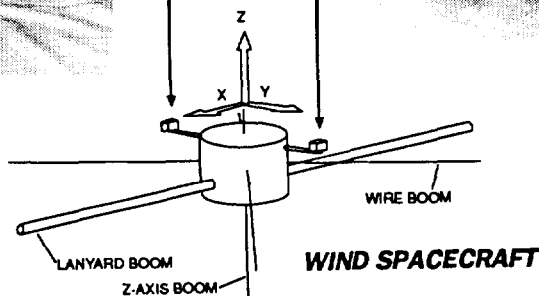
INSTRUMENT COMPONENTS AND FIELDS OF VIEW



ESSA BOOM UNIT



SST/PESA BOOM UNIT



TRANSIENT GAMMA-RAY SPECTROMETER (TGRS)

EXPERIMENT OVERVIEW

TGRS will detect transient gamma-ray burst events and will make the first high-resolution spectroscopic survey of cosmic gamma-ray bursts, and will also make measurements of gamma-ray lines in solar flares. Cosmic gamma-ray bursts are among the most violent and energetic processes known to exist in nature, characteristically emitting most of their luminosity at gamma-ray wavelengths. The high resolution spectroscopy of solar flares will contribute to the study of solar flare activities and help in understanding the coupling between the active corona and photosphere.

SCIENCE OBJECTIVES

To provide the first high-resolution spectroscopic survey of cosmic gamma-ray bursts and the first high-resolution spectroscopy of solar flares, and search for possible diffuse background lines and monitor the 511 keV positron annihilation radiation from the galactic center.

DESCRIPTION OF INSTRUMENT

The TGRS instrument consists of four assemblies: detector-cooler assembly, pre-amp, and analog processing unit, all mounted on a tower on the +Z end of the spacecraft, and a digital processing unit mounted in the body of the spacecraft. The detector is a 215 cm³ high purity n-type germanium crystal of dimensions: 6.7 cm (diameter) X 6.1 cm (length), radiatively cooled to 85 degrees K. The germanium serves as a reaction medium for incoming gamma rays, which, depending on their energy, are either stopped by or passed through the detector crystal. Particle energy and angle of incidence are calculated based on a number of primary and secondary interaction processes, including photoelectric, Compton, pair and bremsstrahlung radiation as well as the ionization energy losses of secondary electrons. A two-stage cooler surrounds the detector, providing a field of view of 170 degrees. Gamma-ray bursts and solar flares are expected to be detected at a frequency of several per week, with typical durations between 1 second and several minutes. Between bursts the instrument is maintained in a waiting mode, measuring background counting rates and energy spectra. When a burst or flare occurs, the instrument switches to a burst mode, where each event in the detector is pulse-height analyzed and time tagged in a burst memory. Then the instrument switches to a dump mode for reading out the burst memory.

MEASUREMENT OBJECTIVES

To obtain:

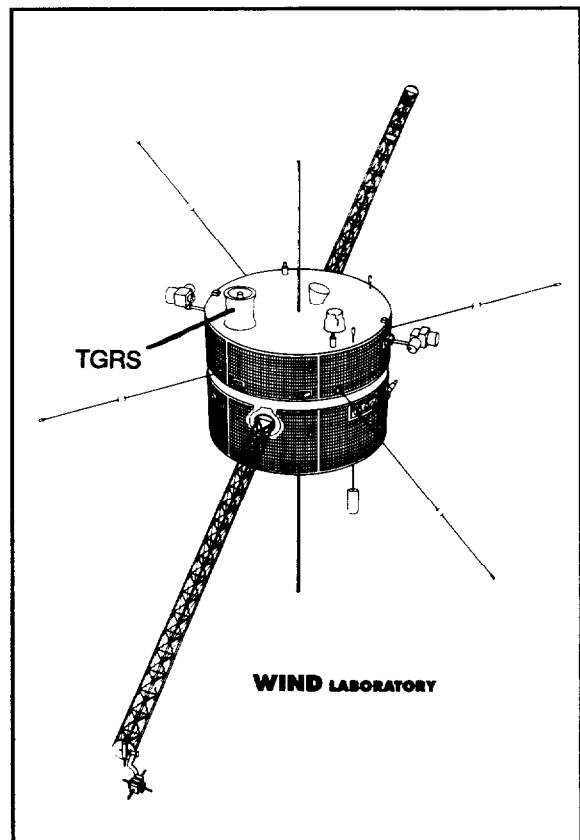
- Spectroscopic measurements of transient gamma-ray events, in the energy range from 15 keV to 10 MeV.
- Energy resolution of 2.0 keV @ 1.0 MeV ($E/\Delta E = 500$).
- Monitoring of the time variability of the 511 keV line emission from the galactic center, on time scales from ~2 days to >1 year.

INSTRUMENT RESOURCES

- Weight (kg): 18.89
- Power (Watts ave.): 7.0
- Telemetry (kbps): .376

PRINCIPAL INVESTIGATOR

Dr. B. J. Teegarden
NASA/ Goddard Space Flight Center
Nuclear Astrophysics Branch
Code 661
Greenbelt, Maryland 20771

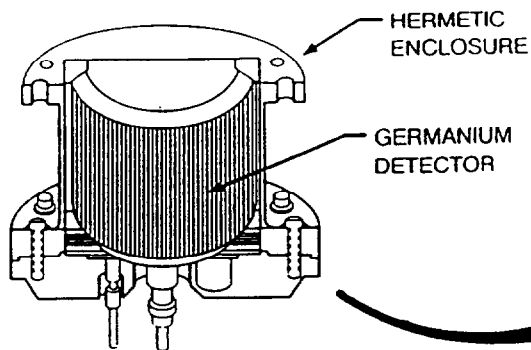


GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

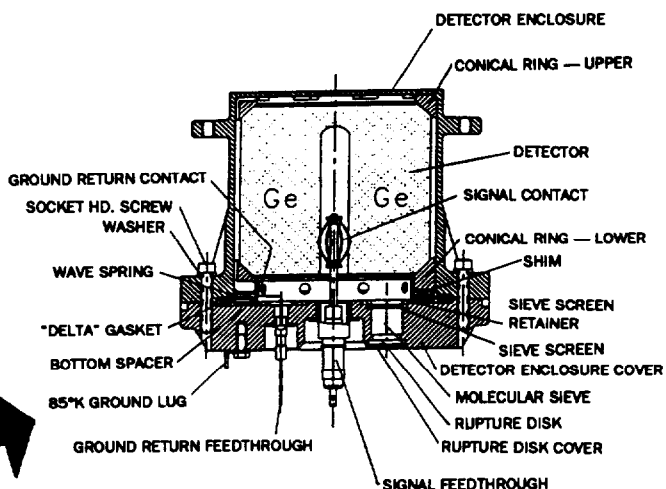
WIND SPACECRAFT INSTRUMENTATION

TRANSIENT GAMMA-RAY SPECTROMETER (TGRS)

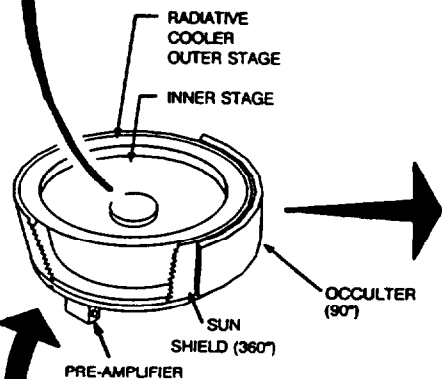
INSTRUMENT COMPONENTS



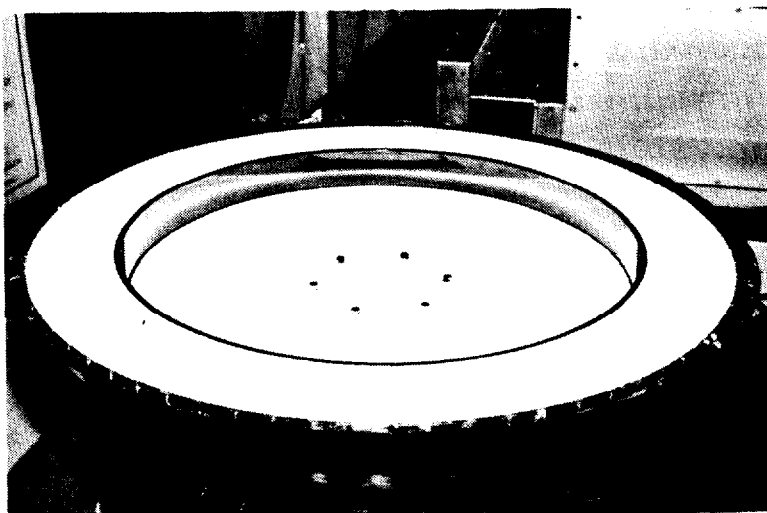
Ge DETECTOR



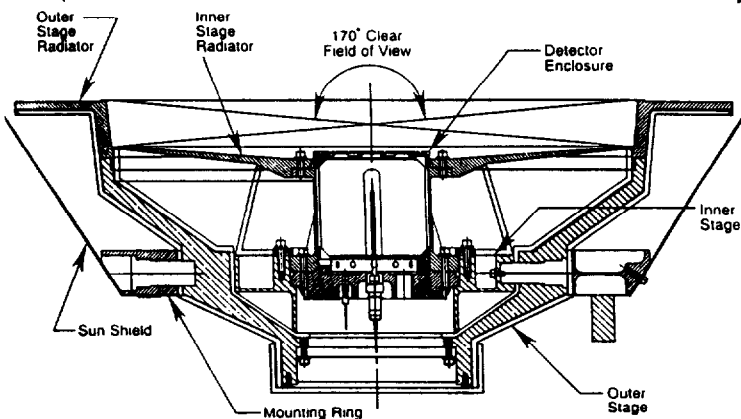
CROSS SECTION OF DETECTOR



WIND SPACECRAFT



(OUTER STAGE RADIATOR APPROXIMATE DIAMETER: 47 CM)



CROSS-SECTIONAL VIEW OF TGRS GERMANIUM DETECTOR AND RADIATIVE COOLER ELEMENTS

RUSSIAN GAMMA-RAY SPECTROMETER (KONUS)

EXPERIMENT OVERVIEW

The objective of Konus is to perform gamma-ray burst studies similar to the TGRS studies. It will perform event detection and will measure time history and energy spectra. Although Konus has lower resolution than TGRS, it has broader area coverage to complement that of TGRS so that, when their data are combined, they provide coverage of the full sky. Konus is the first Russian instrument to fly on an American satellite since civil space cooperation between the U.S. and Russia was resumed in 1987.

SCIENCE OBJECTIVES

To continuously monitor cosmic gamma-ray bursts and solar flares in the energy range 10 keV to 10 MeV.

MEASUREMENT OBJECTIVES

To obtain:

- Measurement of gamma-ray burst energy spectra over the energy range 10 keV to 10 MeV, with energy resolution $E/\Delta E = 15$ @ 200 keV.
- Measurement of burst time histories in three energy ranges covering 10 to 770 keV.
- High-time-resolution measurement (2 ms resolution) for the high-intensity sections of a burst time history.
- Continuous measurement of the gamma- and cosmic-ray background, interrupted only to read out bursts.

DESCRIPTION OF INSTRUMENT

The Konus instrument consists of two Russian sensors mounted on the top and bottom of the spacecraft aligned with the spin axis, a U.S. interface box, and a Russian electronics package mounted in the spacecraft body. The sensors, copies of ones successfully flown on the Soviet COSMOS, VENERA and MIR missions, are identical and interchangeable NaI scintillation crystal detectors of 200 cm² area, shielded by Pb/Sn. The design and location of the two sensors ensure practically isotropic angular sensitivity. The relative count rates recorded by the two detectors can provide a burst source locus to within a few degrees relative to the spin axis. On-board analysis of background and burst events is performed by four pulse height analyzers, four time history analyzers, two high resolution time history analyzers and a background measurement system.

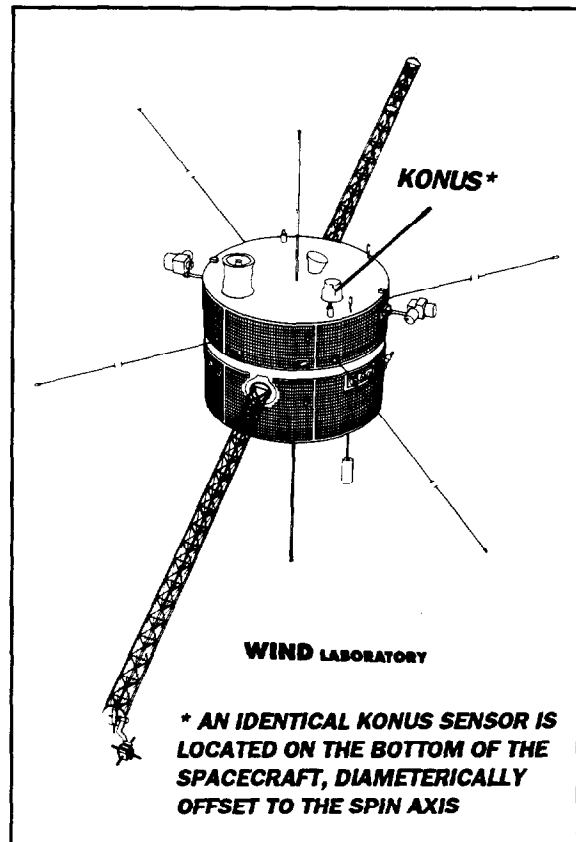
INSTRUMENT RESOURCES

- Weight (kg): 21.8
- Power (Watts ave.): 7.0
- Telemetry (kbps): .055

PRINCIPAL INVESTIGATORS

Dr. T. L. Cline
NASA/ Goddard Space Flight Center
Greenbelt, Maryland 20771

Dr. E. Mazets
IOFFE Physical Technical Institute
St. Petersburg, Russia

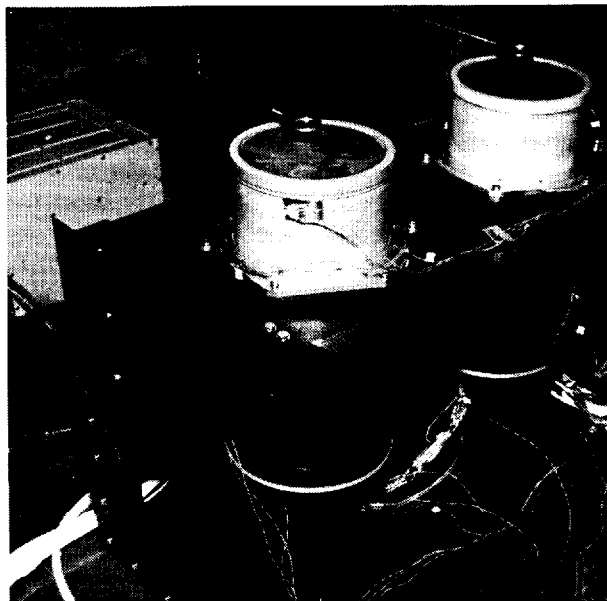
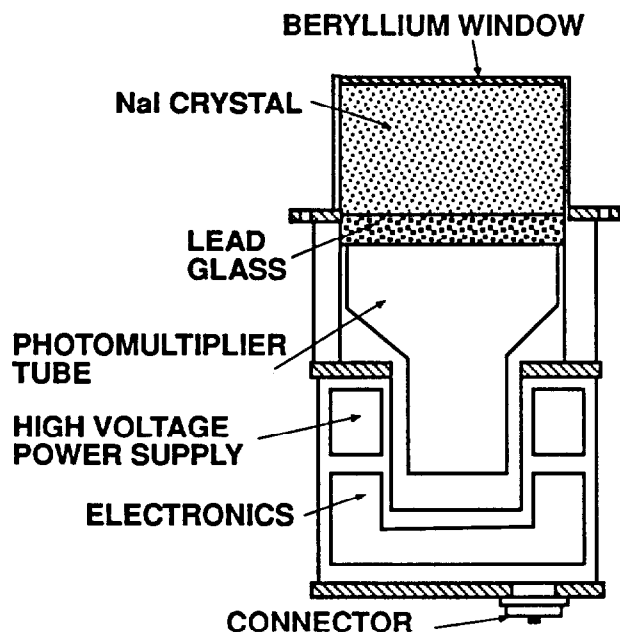


GLOBAL GEOSPACE SCIENCE (GGS) PROGRAM

WIND SPACECRAFT INSTRUMENTATION

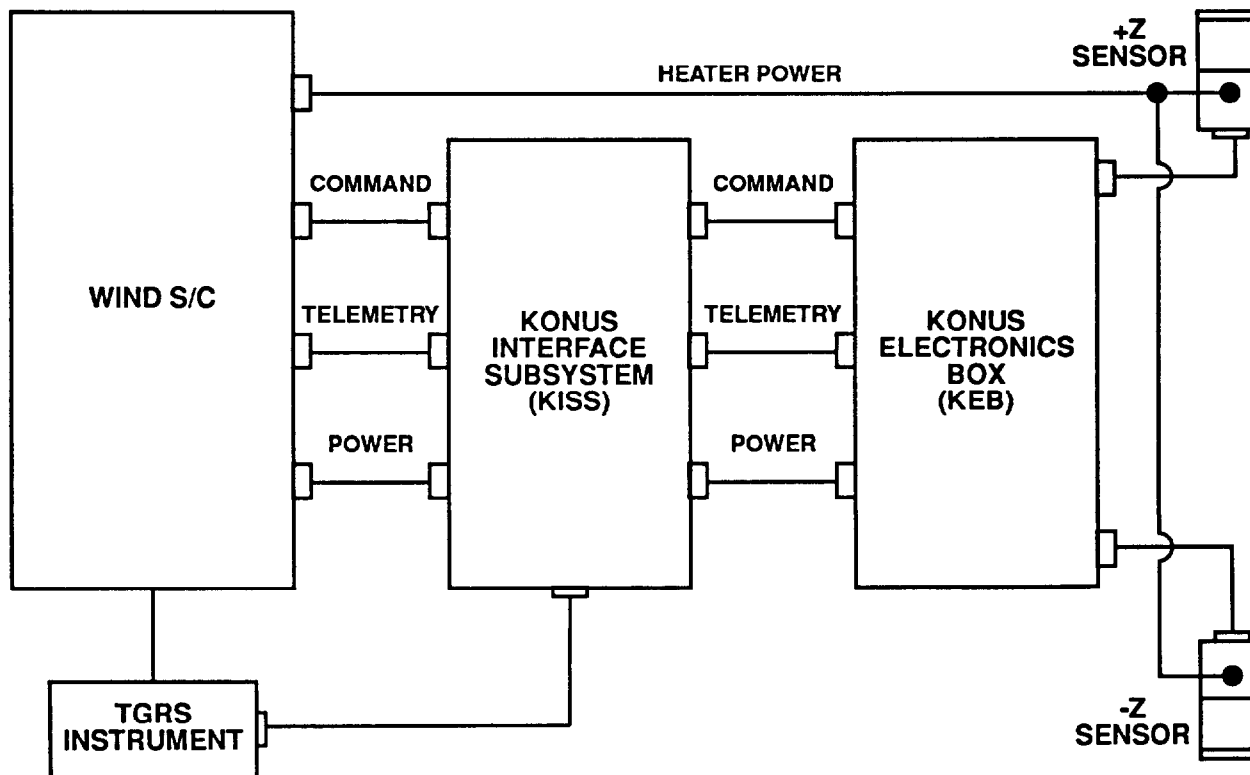
RUSSIAN GAMMA-RAY SPECTROMETER (KONUS)

INSTRUMENT COMPONENTS



The two Konus sensors, mounted on a test fixture for thermal-vacuum testing. The Konus Electronics Box is visible in the background and two Cesium-137 sources are mounted above the sensors for calibration.

INSTRUMENT INTERFACES



LAUNCH VEHICLE DESCRIPTION

A Delta II 7925-10 Expendable Launch Vehicle, as shown in Figure 4, will be used to launch the Wind spacecraft. The Delta II provides three stages to insert the spacecraft into the proper transfer orbit. The first stage is powered by a Rocketdyne RS-27A liquid propellant engine with a 12:1 expansion ratio. This stage is augmented by nine Hercules lightweight graphite epoxy solid rocket motors (GEMS). The second stage is powered by an Aerojet AJ10-118K pressure-fed propulsion system. The first and second stage engines are gimbal mounted for attitude control. A guidance compartment in the second stage contains flight control, inertial guidance, instrumentation, range safety, tracking, and power equipment. A nitrogen cold-gas system is installed on the second stage to provide roll control for the entire flight and pitch and yaw control during coast flight. The Delta II second-to-third stage interstage provides a spin table to which the third stage is mounted. The third stage is a Thiokol (PAM-D) Star 48B solid propellant rocket motor. The Wind spacecraft is secured to the Delta II third stage by the use of a 3712 Spacecraft Attach Fitting. The spacecraft will be mounted to the 3712 with a two-piece v-block type clamp assembly.

A 3.0 meter (10 ft) diameter aluminum fairing assembly encapsulates the spacecraft during launch. The fairing is jettisoned during second stage powered flight. Acoustic blankets of 3.8 cm (1.5 in) thickness are mounted to the fairing nose section and to the upper portion of the 2.4 m (8 ft) diameter cylindrical section; acoustic blankets mounted to the 3.0 m diameter cylindrical section of the fairing are 7.6 cm (3 in) thick. Fairing access doors are located to allow access to safety critical spacecraft components. Delta II 7925-10 ELV characteristics are summarized in Table 2. Figure 5 reflects a cross sectional view of the Delta II Launch Vehicle with the Wind spacecraft integrated.

DELTA 7925-10 LAUNCH VEHICLE

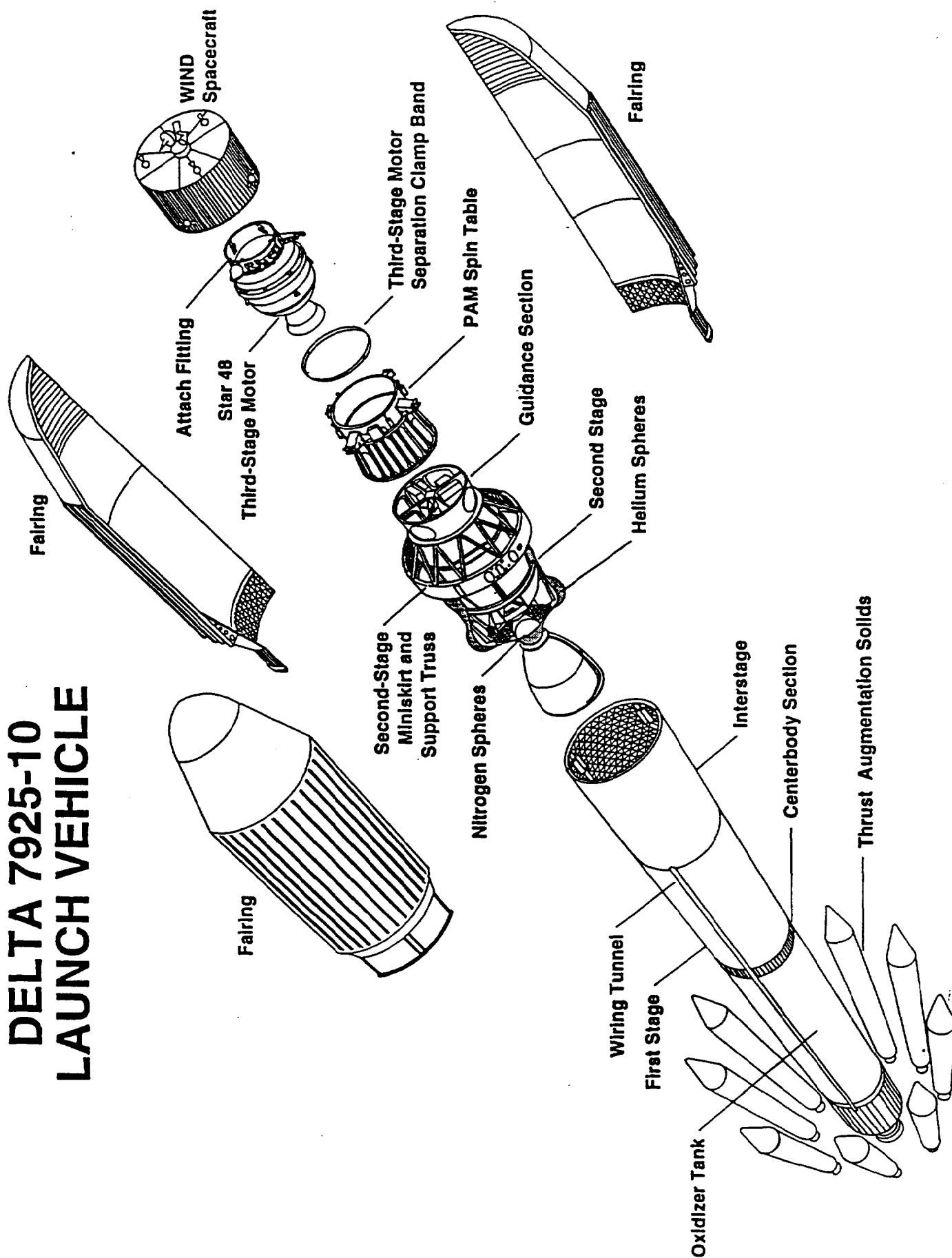


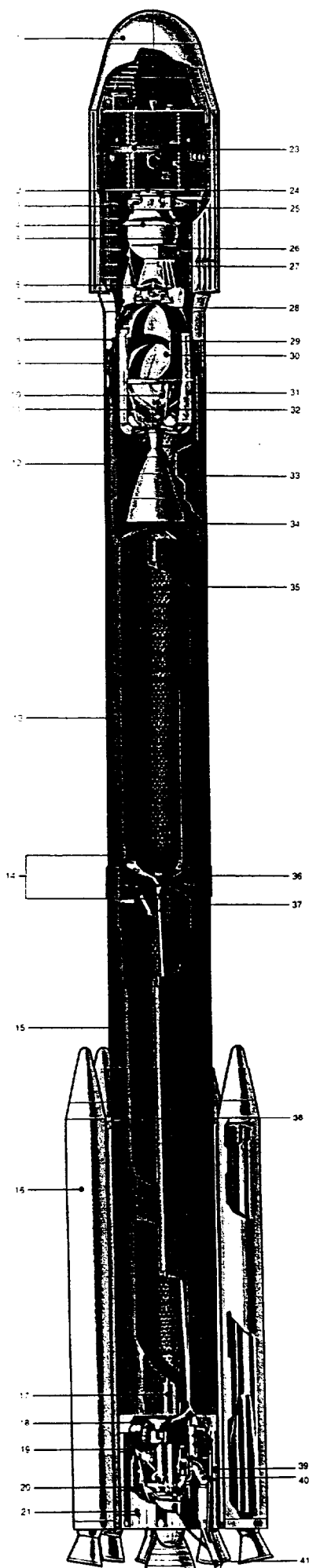
Figure 4.
31

Table 2. Delta II 7925-10 Vehicle Characteristics

| Characteristics | Strap-On solids | First stage | Second stage | Third stage |
|---------------------------|-------------------------------|--------------------|-------------------------------------|--------------------|
| Length (ft) | 42.5 | 85.6 | 19.6 | 6.7 |
| Diameter (ft) | 3.3 | 8 | 8 | 4.1 |
| Total weight (lb) | 28,618 (GL)* 28,800 (AL)** | 225,763 | 15,405 | 4,721 |
| Engine/motor | GEM | RS-27A | AJ10-118K | Star-48B |
| Manufacturer | Hercules | Rocketdyne | Aerojet | MTI |
| Quantity | 9 | 1 | 1 | 1 |
| Propellants | Solid | LOX/RP-1 | N ₂ O ₄ /A-50 | Solid |
| Propellant weight (lb) | 25,800 ea | 211,902 | 13,378 | 4,430 |
| Thrust (lb) – SL – VAC | 98,870 ea 110,820 ea | 201,000 245,163 | — 9,830 | — 15,100 |
| Isp (sec) – SL – VAC | 245.7 273.8 | 255.6 303.1 | — 318.9 | — 292.6 |
| Burn time (sec) | 63 | 260.8 | 431.1 | 87.1 |
| Expansion ratio | 8.28:1 | 12:1 | 85:1 | 54.8:1 |

*Ground lit

**Air lit



Delta II 7925-10

- | | |
|--------------------------------------|--|
| 1. Fairing (10-ft Diameter) | 22. First-Stage Engine (Rocketdyne RS-27) 12:1 Nozzle Expansion Ratio |
| 2. Payload Attach Fitting | 23. Spacecraft |
| 3. Acoustic Blanket | 24. Nutation Control System (NCS) |
| 4. Thiokol Star 48B Motor | 25. Telemetry Antenna |
| 5. Spin Rockets | 26. Spin Table |
| 6. Second-Stage Guidance Section | 27. Spin Table Support |
| 7. Support Truss | 28. Fuel Tank |
| 8. Miniskirt Structure Assembly | 29. Oxidizer Pressurization and Vent Tubing |
| 9. Second-Stage Separation Springs | 30. Oxidizer Tank |
| 10. Attitude Control System Gas Jets | 31. Insulation Blanket |
| 11. Helium Sphere | 32. Nitrogen Sphere |
| 12. Interstage | 33. Second-Stage Engine, Aerojet (AJ10-118) |
| 13. Fuel Tank | 34. Fuel Tank Vent and Relief Valve |
| 14. Float Switches | 35. Baffle Installation (11 places) |
| 15. Liquid Oxygen Tank | 36. Center Body Section (Equipment Installation) |
| 16. Graphite Epoxy Motor | 37. Fuel Transfer Tube |
| 17. Wire Tunnel | 38. Frame Installation |
| 18. Nitrogen Sphere | 39. Engine and Accessories Section |
| 19. Hydraulic Accessory Unit | 40. Fuel Fill Duct |
| 20. Liquid Oxygen Fill Duct | 41. Turbine Exhaust Duct Extension |
| 21. Boattail Section | |

Figure 5. Cross Sectional View of the Delta II Launch Vehicle With the Wind Spacecraft Integrated

MISSION SUPPORT

Mission operations will be conducted from Goddard Space Flight Center (GSFC) for Wind, using NASA institutional and project-unique support facilities. These facilities will provide for command and control, command management, orbit and attitude computation, mission analysis, data capture and processing, and science operations. Tracking and data acquisition support will be provided by the JPL/DSN.

COMMAND AND CONTROL OPERATIONS

Command and control operations associated with the spacecraft will be supported from the Payload Operations Control Center (POCC) located at GSFC. Spacecraft control functions, which are not a responsibility of the GGS POCC, include the instrument software which will be updated and verified by the investigators at the Remote Data Analysis Facilities (RDAFs). Instrument performance monitoring will be the responsibility of the investigators at the RDAFs and reported to the Science Planning and Operations Facility (SPOF). Investigators will be responsible for instrument data base definition and maintenance. In addition, overflow areas will be required with extra terminals and up to twenty communication positions for subsystem engineer monitoring of TV coverage and GGS displays during the launch and early checkout phase of the mission.

COMMAND MANAGEMENT

A dedicated Command Management System (CMS) will be located at the GGS POCC at GSFC and operated by the Flight Operations Team (FOT). The CMS will provide the main operational interface between the mission planning function and the GGS POCC for science planning and spacecraft inputs. The Mission Operations and Data Systems Directorate (MO&DSD) developed the operational software for the mission planning function. The CMS will accept spacecraft and instrument commands, command timelines, and instrument microprocessor loads. It will also perform validity and constraint checks, and prepare the input for subsequent uplink by the POCC at appropriate times.

ORBIT & ATTITUDE COMPUTATION AND MISSION ANALYSIS

The FDF will provide all orbit and attitude support required for the Wind mission, including mission analysis, orbit and attitude determination, and planning and implementation of maneuvers. This will involve the development of orbit and attitude scenarios that optimally satisfy science requirements and engineering constraints, including the analysis to determine launch time, launch window, optimum orbit, network coverage, and orbit and attitude parameters and maneuvers. The operational attitude support will require processing of attitude sensor telemetry data provided by the GGS POCC. Orbit determination will utilize radiometric tracking data supplied by the DSN. During the Wind mission,

the FDF will provide the GGS POCC with DSN station view period predicts and other orbit products (i.e., shadows, angles, etc.). Definitive and predicted attitude and ephemeris files will be created and routed to the CDHF. FDF will be capable of processing vehicle Delta Inertial Guidance System (DIGS) data with a nominal third stage to produce an initial vector for DSN acquisition.

DATA CAPTURE AND PROCESSING

Data received by the stations will be routed from the DSN DCF via NASA Communications Network (NASCOM) to the Generic Data Capture Facility (GDCF) where it will be captured and to the POCC for health and safety monitoring by the FOT. All telemetry data (real time and playback) will be processed by the GDCF, either directly or by station replay, to produce level-0 data sets. In addition, GDCF will limit check and/or plot selected telemetry data for the FOT. The level-0 data sets will be delivered to the CDHF within forty-eight hours of receipt (with a goal of twenty-four hours). The CDHF, an ISTP project-unique facility dedicated for the processing of scientific data, will receive level-0 data on a daily basis. The level-0 data, together with orbit and attitude data, will be used to produce key parameters which will be maintained on line and made available via electronic transfer to users on request. The DDF will assemble the components of the distribution data on a physical medium which will later be mailed to the users, designated Principal Investigators (PIs), Co-Investigators (Co-Is), and the National Space Science Data Center (NSSDC).

SCIENCE OPERATIONS

Data analysis and theoretical studies will be conducted by members of the ISTP science team through the PIs and/or Co-Is of the Wind science instruments. Instrument operation plans will be available to the SPOF from the CDHF. The SPOF is a dedicated project-unique facility, staffed by representatives of the Project Scientist and manned eight hours per day, five days per week. Under the direction of the Project Scientist, the SPOF will generate coordinated science plan recommendations with the PIs which will be translated into command loads within the CMS and uplinked from the GGS MOR by the FOT. The SPOF will also perform science coordination between the Wind and Polar missions, the NSSDC, and the RDAFs, and will receive data quality reports from the CDHF. Workstations within the SPOF will be provided by the ISTP project.

TRACKING SUPPORT

Communication between the ground system and Wind spacecraft will be through the spacecraft S-band transponder via the DSN. A 120-minute contact will be required each day. This DSN contact will normally be sufficient for tracking, commanding, performing data dumps, and monitoring the performance of the spacecraft. There is a requirement for additional tracking data after Delta-V maneuvers. Increased tracking contacts from alternating Northern and Southern hemisphere DSN stations are required for the first forty-eight hours after a maneuver.

DATA ACQUISITION SUPPORT

A 120-minute contact through the spacecraft S-band transponder via the DSN will be required each day for tape recorder dumps at 64 kb/sec and real-time data transmission simultaneously on a subcarrier (housekeeping and/or science data) of approximately 5.56 kb/sec. A twice-data-rate option exists for Wind operations inside 60 Re, in which case the playback rate is 128 kb/sec and the simultaneous real-time rate is 11.1 kb/sec. A one-half playback contingency rate option exists, which if used, would require twice the DSN contact time for the recorder dumps. DSN monitor data containing quality and accounting information will be sent to the GGS POCC in real-time for all data streams.

MISSION MANAGEMENT RESPONSIBILITY

Overall direction and evaluation of the NASA Space Physics Program is the responsibility of the NASA Associate Administrator for Space Science, who has delegated authority for the direct management of this program to the Director, Space Physics Division. The NASA GGS Program Manager, in turn, has been delegated the authority by the Director, Space Physics Division for ensuring the performance of all functions necessary to fulfill NASA responsibilities with respect to the Wind and Polar missions.

The lead NASA center for Wind is the Goddard Space Flight Center. Responsibility for management of the Project has been assigned to the GGS Project Office within the Flight Projects Directorate.

NASA HEADQUARTERS

| | |
|--|-----------------------------|
| Associate Administrator, Space Science | Dr. Wesley T. Huntress, Jr. |
| Director, Space Physics Division | Dr. George L. Withbroe |
| Program Manager, Wind | William T. Huddleston |
| Director, Launch Vehicles Office | Charles R. Gunn |

GODDARD SPACE FLIGHT CENTER

| | |
|---------------------------------------|-----------------------|
| Director | Dr. John M. Klineberg |
| Director, Flight Projects Directorate | Vernon J. Weyers |
| Project Manager, Wind | John Hrastar |
| Project Scientist, ISTP | Dr. Mario H. Acuna |
| Project Scientist, Wind | Dr. Keith W. Ogilvie |

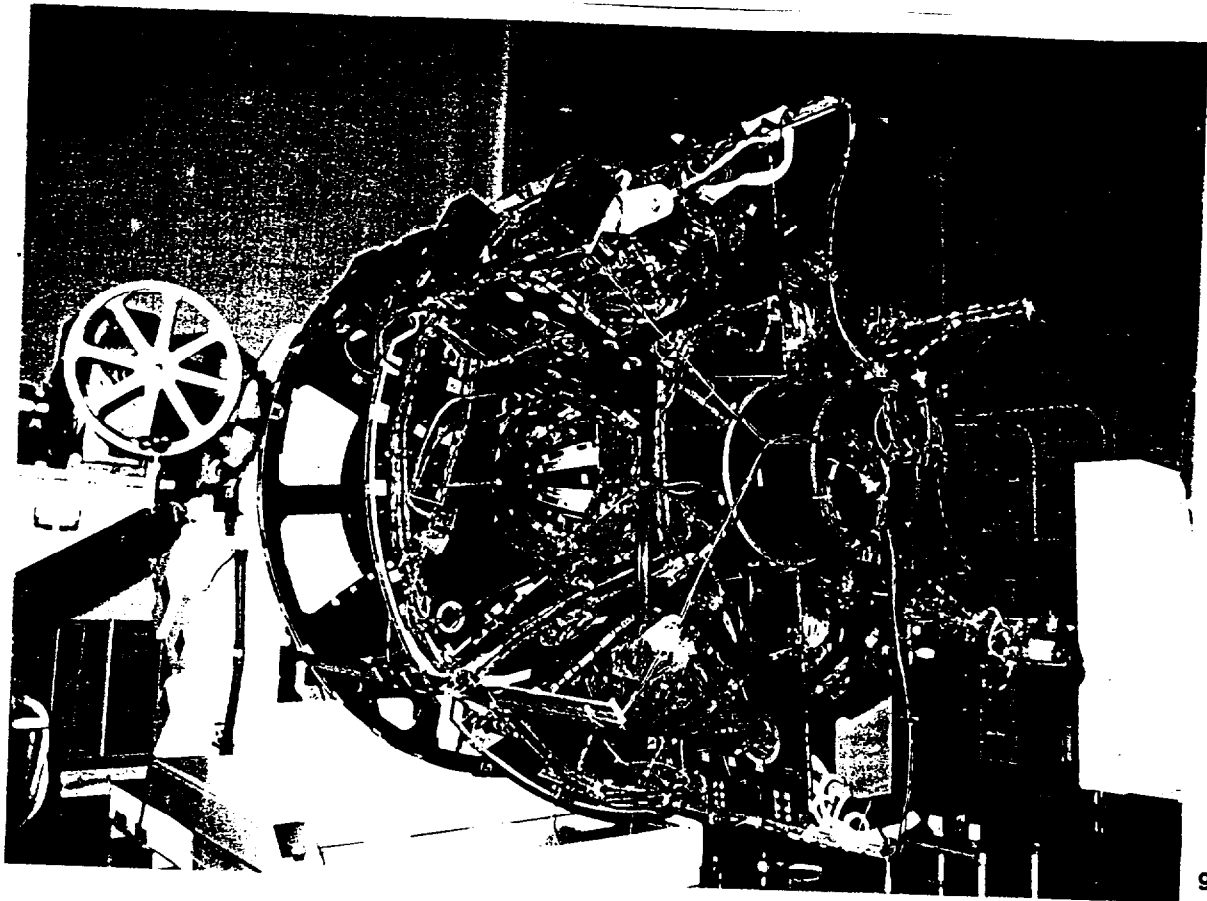
MISSION COSTS

Funding requirements for the Wind laboratory (spacecraft and instruments) is included within a single budget line entry for the Global Geospace Science (GGS) program. This program includes the development of both the Wind and the Polar laboratory. Although the exact separation of cost between both missions is difficult, Table 3 reflects a good approximation of Wind related cost.

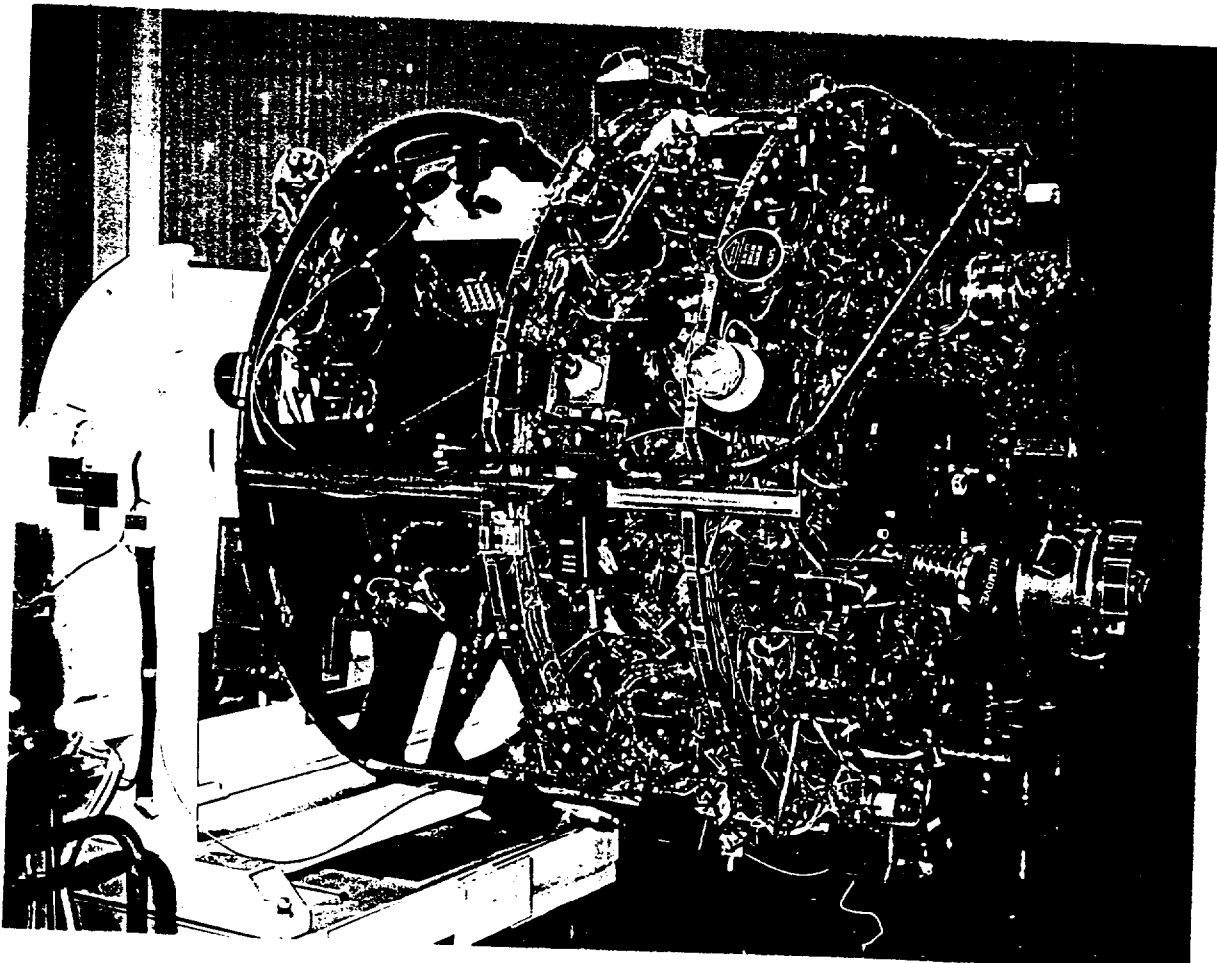
Table 3. Wind Funding Profile (\$M)

| | |
|--|-------|
| Spacecraft Development, Integration and Test | 105.6 |
| Instrument Development | 56.9 |
| Ground System Development | 10.6 |
| Mission Operations and Data Analysis (MO&DA) | 16.1 |
| Launch Vehicle | 44.6 |
| Total | 233.8 |

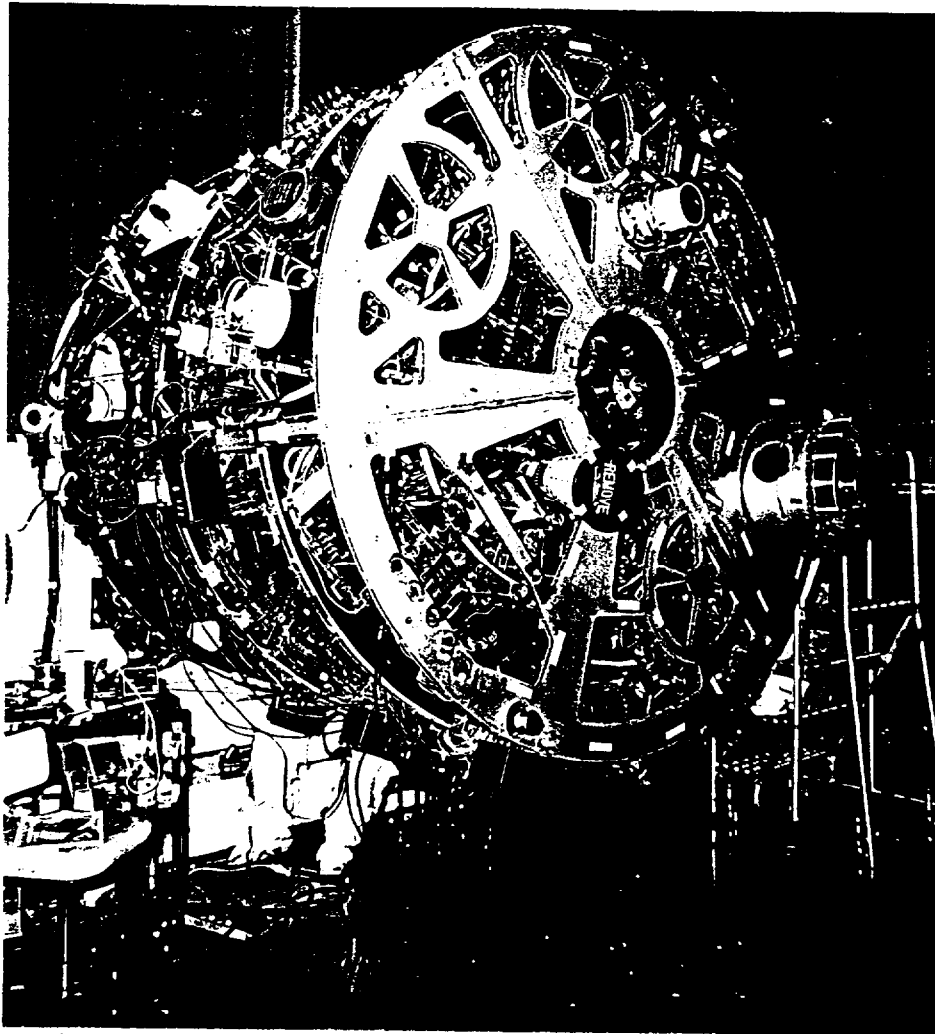
APPENDIX A: SPACECRAFT INTEGRATION PHOTOGRAPHS



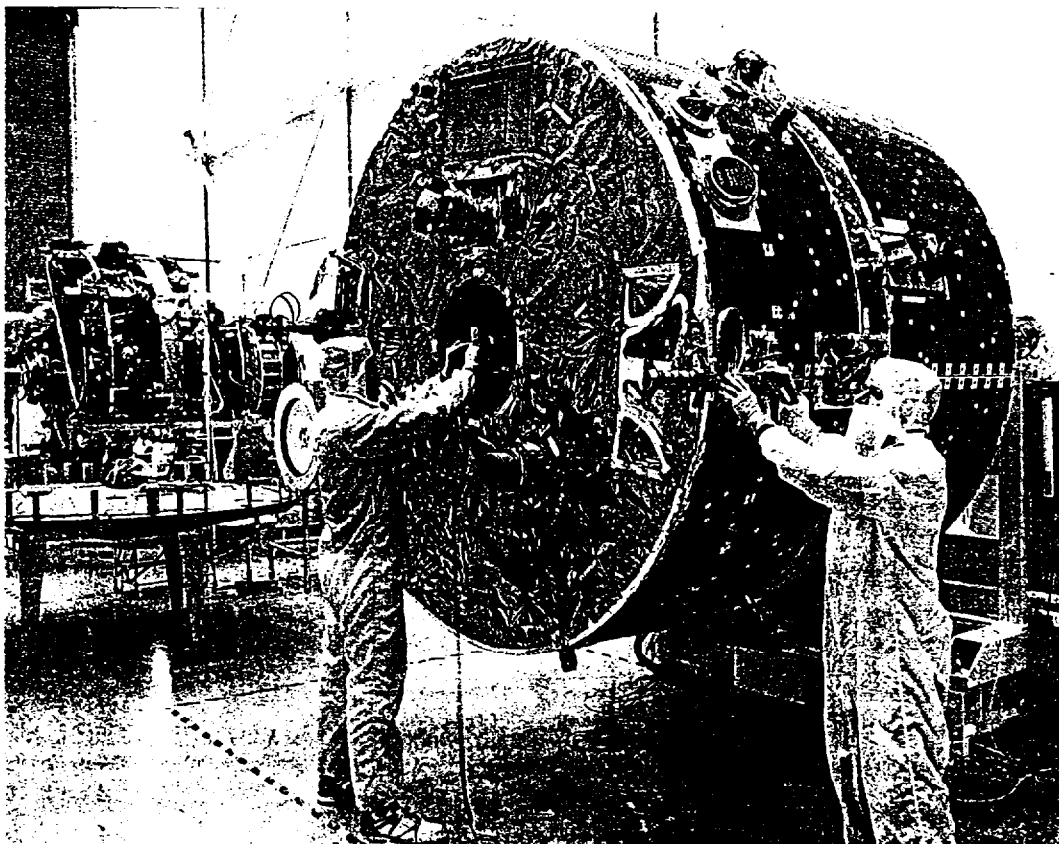
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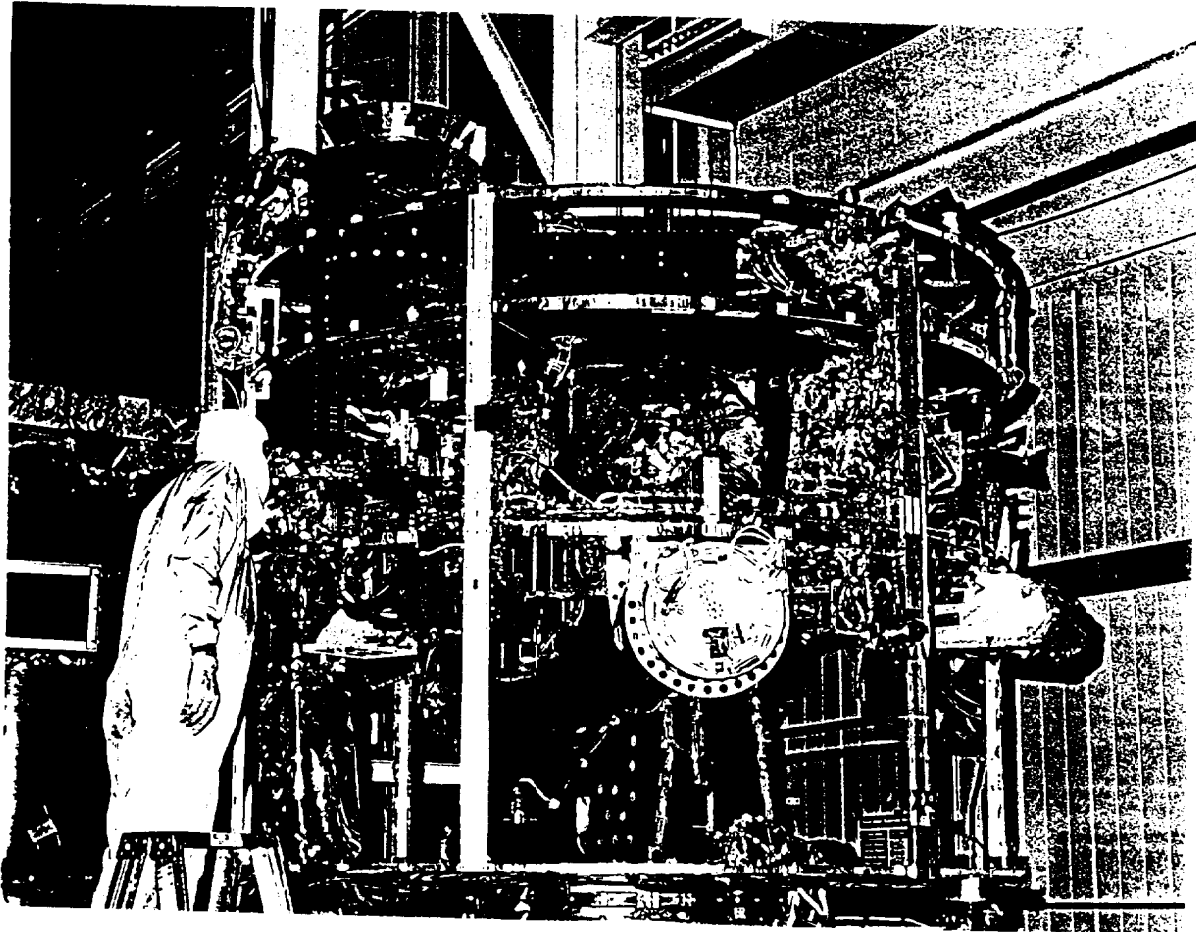
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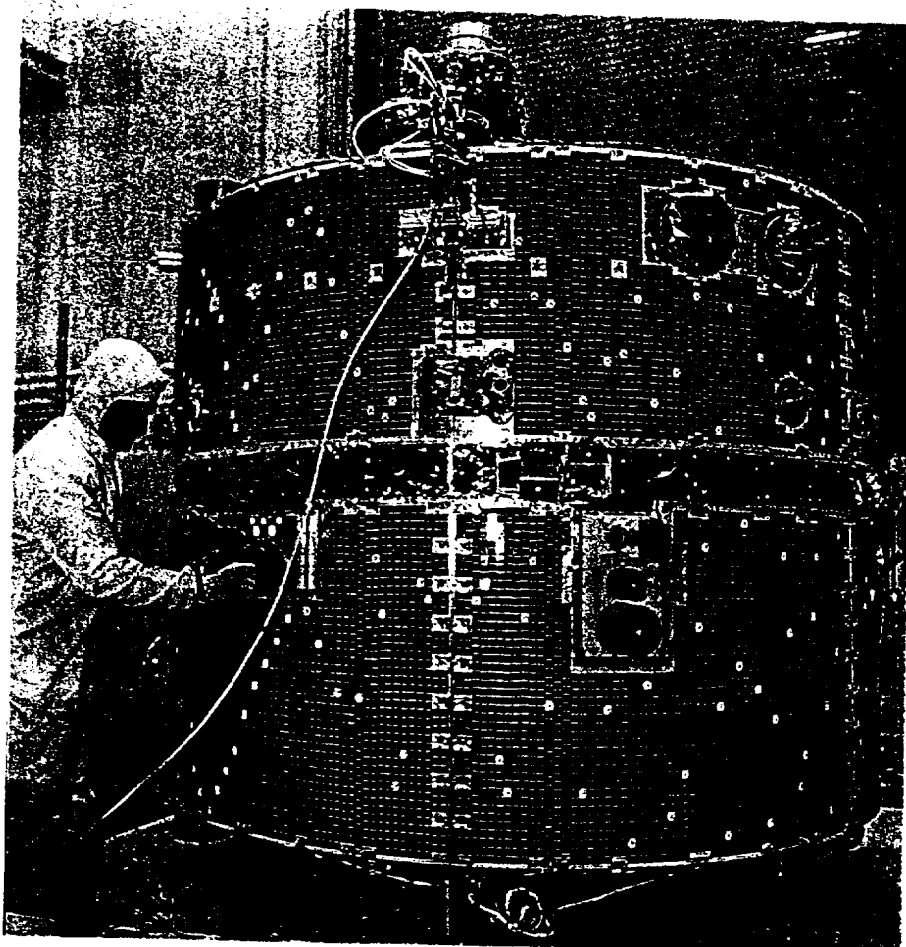
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Appendix B: *LIST OF ACRONYMS*

| | |
|--------|---|
| ACADS | Attitude Control and Determination System |
| BCA | Battery Charge Assembly |
| C&DH | Command and Data Handling |
| CAP | Command and Attitude Processor |
| CCAFS | Cape Canaveral Air Force Station |
| CDHF | Central Data Handling Facility |
| CDU | Command Distribution Unit |
| CMS | Command Management System |
| Co-I | Co-Investigator |
| COSTR | Collaborative Solar-terrestrial Research |
| DCF | Data Capture Facility |
| DDF | Data Distribution Facility |
| DIGS | Delta Inertial Guidance System |
| DSN | Deep Space Network |
| DTR | Digital Tape Recorder |
| EESA | Electron Electrostatic Analyzer |
| ELV | Expendable Launch Vehicle |
| EPACT | Energetic Particle Acceleration Composition Transport |
| ESA | European Space Agency |
| FDF | Flight Dynamics Facility |
| FOT | Flight Operations Team |
| GDCF | Generic Data Capture Facility |
| GGs | Global Geospace Science |
| GSFC | Goddard Space Flight Center |
| GTM | GGs Telemetry Module |
| HSA | Horizon Sensor Assembly |
| Hydra | Fast Plasma Analyzer |
| IACG | Inter-Agency Consultative Group for Space Science |
| IKI | Russian Space Institute |
| ISAS | Institute of Space and Astronautical Science (Japan) |
| ISTP | International Solar-terrestrial Physics |
| JPL | Jet Propulsion Laboratory |
| Konus | Soviet Gamma Ray Spectrometer |
| MFI | Magnetic Fields Investigation |
| MO&DSD | Mission Operations and Data Systems Directorate |
| MOR | Missions Operations Room |
| NASA | National Aeronautics and Space Administration |
| NASCOM | NASA Communications Network |
| NSSDC | National Space Science Data Center |
| PESA | Proton Electrostatic Analyzer |
| PI | Principal Investigator |
| POCC | Payload Operations Control Center |
| PRA | Pyro Relay Assembly |
| PSE | Power Supply Electronics |
| RCS | Reaction Control System |

| | |
|-------------------|--|
| RDAF | Remote Data Analysis Facilities |
| RE | Earth Radii |
| REA | Rocket Engineer Assembly |
| RXO | Redundant Crystal Oscillator |
| SMS | Solar Wind and Suprathermal Ion Composition and Mass Sensor |
| SOHO | Solar and Heliospheric Observatory |
| SPOF | Science Planning and Operations Facility |
| SSA | Sun Sensor Assembly |
| SWE | Solar Wind Experiment |
| TGRS | Transient Gamma Ray Spectrometer |
| 3-D Plasma | Three-Dimensional Plasma and Energetic Particle Analyzer |
| Waves | Radio and Plasma Waves |